SID società Italiana di Diabetologia

SLOG

DIABETES PREGNANCY and TECHNOLOGY in Lombardy - 2024

DIABETE PRE-GESTAZIONALE
MONITORAGGIO CLINICO-ECOGRAFICO E TIMING PARTO

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UNIVERSITÀ DEGLI STUDI DI MILANO

Bergamo, 8 Giugno 2024

Sistema Socio Sanitario
Regione Lombardia
ASST Santi Paolo e Carlo

CONFLITTO DI INTERESSI

La dr.ssa STEFANIA TRIUNFO dichiara di NON aver ricevuto negli ultimi due anni compensi o finanziamenti da Aziende Farmaceutiche e/o Diagnostiche

Dichiara altresì il proprio impegno ad astenersi, nell'ambito dell'evento, dal nominare, in qualsivoglia modo o forma, aziende farmaceutiche e/o denominazione commerciale e di non fare pubblicità di qualsiasi tipo relativamente a specifici prodotti di interesse sanitario (farmaci, strumenti, dispositivi medico-chirurgici, ecc.).

MONITORAGGIO CLINICO-ECOGRAFICO

MADRE

- ✓ LIFESTYLE
- ✓ WEIGHT GAIN TARGET
- ✓ GLYCEMIC TARGET

FETO

- ✓ PLACENTAL VASCULAR SUPPLY
- ✓ ANATOMY
- ✓ GROWTH

MONITORAGGIO CLINICO-ECOGRAFICO

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NUTRITION

MONITORAGGIO CLINICO

«È ben documentato che la Terapia Nutrizionale può **migliorare il controllo glicemico**, ed è **parte integrante del trattamento** e dell'autogestione del diabete»

Tre **obiettivi** della Terapia Nutrizionale

1. *Adeguata nutrizione materna e fetale*
2. *Adeguato apporto calorico, vitaminico e minerale*
3. *Controllo glicemico ottimale in assenza di chetonuria/chetonemia*

«La terapia nutrizionale deve essere **personalizzata** in relazione a abitudini alimentari, culturali, etniche, stato economico e BMI pregravidico»

«Anche in caso di obesità grave, l'utilizzo di diete drasticamente ipocaloriche è **controindicato** ridurre l'apporto calorico a < **1500 kcal/die**»

PASTO	RIPARTIZIONE KCAL
COLAZIONE	**10-15%**
SPUNTINO	5-10%
PRANZO	**20-30%**
SPUNTINO	5-10%
CENA	**30-40%**
SPUNTINO bed-time	5-10%

2° trimestre: **+ 340** kcal/die

3° trimestre: **+ 450** kcal/die

PHYSICAL ACTIVITY

MONITORAGGIO CLINICO

Sistema nazionale per le linee guida

Gravidanza fisiologica

Attività fisica

• **Quesito 13** • Quali sono gli effetti dell'attività fisica in gravidanza sulla salute materna e feto-neonatale?

Raccomandazioni

- I professionisti devono informare le donne in gravidanza che iniziare o continuare un'attività fisica moderata in gravidanza non è associato a eventi avversi.
- I professionisti devono informare le donne in gravidanza riguardo i potenziali pericoli di un'attività sportiva che preveda impatto fisico e possa comportare il rischio di cadute e traumi addominali e notevole sforzo fisico.
- I professionisti devono informare le donne che le immersioni subacquee in gravidanza sono risultate associate a difetti congeniti e a malattia fetale da decompressione.

MONITORAGGIO CLINICO

PHYSICAL ACTIVITY

CSEP | SCPE
THE GOLD STANDARD IN EXERCISE SCIENCE AND PERSONAL TRAINING

Frequency: 30-40 minutes per day (**150 minutes per week**), better in the postprandial period not less than 30 minutes each time.

Duration of the activity should **start at 15 minutes** per target heart rate session with an **increase in time of 2 minutes per week until 30-40 minutes** is reached and then maintained.

All aerobic activity should begin with a **warm-up** and **cool-down** of 5 to 10 minutes of lower intensity.

WARM-UP:	EXERCISE:	COOL-DOWN:
5-10min	30-40min	5-10min

Canadian Society for Exercise Physiology, 2015

MONITORAGGIO CLINICO

PHYSICAL ACTIVITY

Attività Fisica nella Gravidanza di Donne con Diabete

Tabella 1. Controindicazioni relative ed assolute all'attività fisica in gravidanza

Relative	Assolute
Precedenti aborti spontanei	Sanguinamenti vaginali
Precedenti parti pre-termine	Rottura delle membrane
Malattie cardio-respiratorie lievi-moderate (Ipertensione, asma ....)	Attività contrattile prematura
Disordini alimentari o malnutrizione	Placenta previa
Gravidanza gemellare dalla 28ª settimana	Incontinenza della cervice, cerchiaggio
Obesità >40 Kg/m²	Ritardo di crescita intra-uterino
Anemia con Hb>10g/dl	Pre-eclampsia
Altre condizioni clinicamente significative di grado lieve-moderato: (Tireopatie, diabete pre-gravidico, ...)	Gravidanza multipla (>2)
	Malattie cardio-respiratorie di grado severo
	Anemia con Hb<10g/dl
	Altre condizioni clinicamente significative di grado severo: (Tireopatie, diabete pre-gravidico, ...)

Tabella 2 . Esercizio fisico nelle donne con diabete tipo 1 in gravidanza

Timing	*2 ore dopo la somministrazione di un analogo rapido*	*8-10 h dopo la somministrazione di un analogo lento*
Valutazione Glicemia PRIMA dell' Esercizio Fisico	< 150 mg/dl Strategia base: 15-30 g di CHO ogni 30-60 minuti di esercizio	≥250 mg/dl Rimandare la seduta, bere acqua, controllare la chetonemia, chetonuria, rivalutare la glicemia dopo 15 minuti
	Metodo semi quantitativo: 1gr di CHO/Kg peso/h esercizio moderato	
	Metodo quantitativo: tabella specifica per peso e tipo di attività	
DOPO l'Esercizio Fisico	Controllare la glicemia al termine della seduta e nelle ore successive fino al mattino successivo per conoscere la risposta glicemica precoce e tardiva all' esercizio fisico	per programmare le successive sedute sedute di esercizio in durata ed intensità e ridurre la terapia insulinica in risposta all'esercizio stesso Personalizzare al massimo gli adeguamenti della terapia insulinica e dell'apporto di CHO in rapporto alle variabili suddette

MONITORAGGIO CLINICO

WEIGHT GAIN TARGETS

INSTITUTE OF MEDICINE
OF THE NATIONAL ACADEMIES

Pre-pregnancy BMI	BMI (kg/m^2)	Total weight gain range (kg)	**Rates of weight gain 2nd and 3rd trimester (kg/week)**
Underweight	>18.5	12.7–18	0.45–0.58
Normal weight	18.5–24.9	11.3–15.9	0.36–0.45
Overweight	25.0–29.9	6.8–11.3	0.22–0.32
Obese (all classes)	>30	5–9	0.18–0.27

BMI body mass index

IOM, 2009
ACOG 2013 , reaffirmed 2020

Safety of low weight gain or weight loss in pregnancies with class 1, 2, and 3 obesity: a population-based cohort study

Kari Johansson, Lisa M Bodnar, Olof Stephansson, Barbara Abrams, Jennifer A Hutcheon

- **Population-based cohort** study
- **15.760 pregnancies** with obesity
- **Follow-up of 7·9 years** (IQR 5.8–9.4)
- **composite outcome inclusive of 10 outcomes**

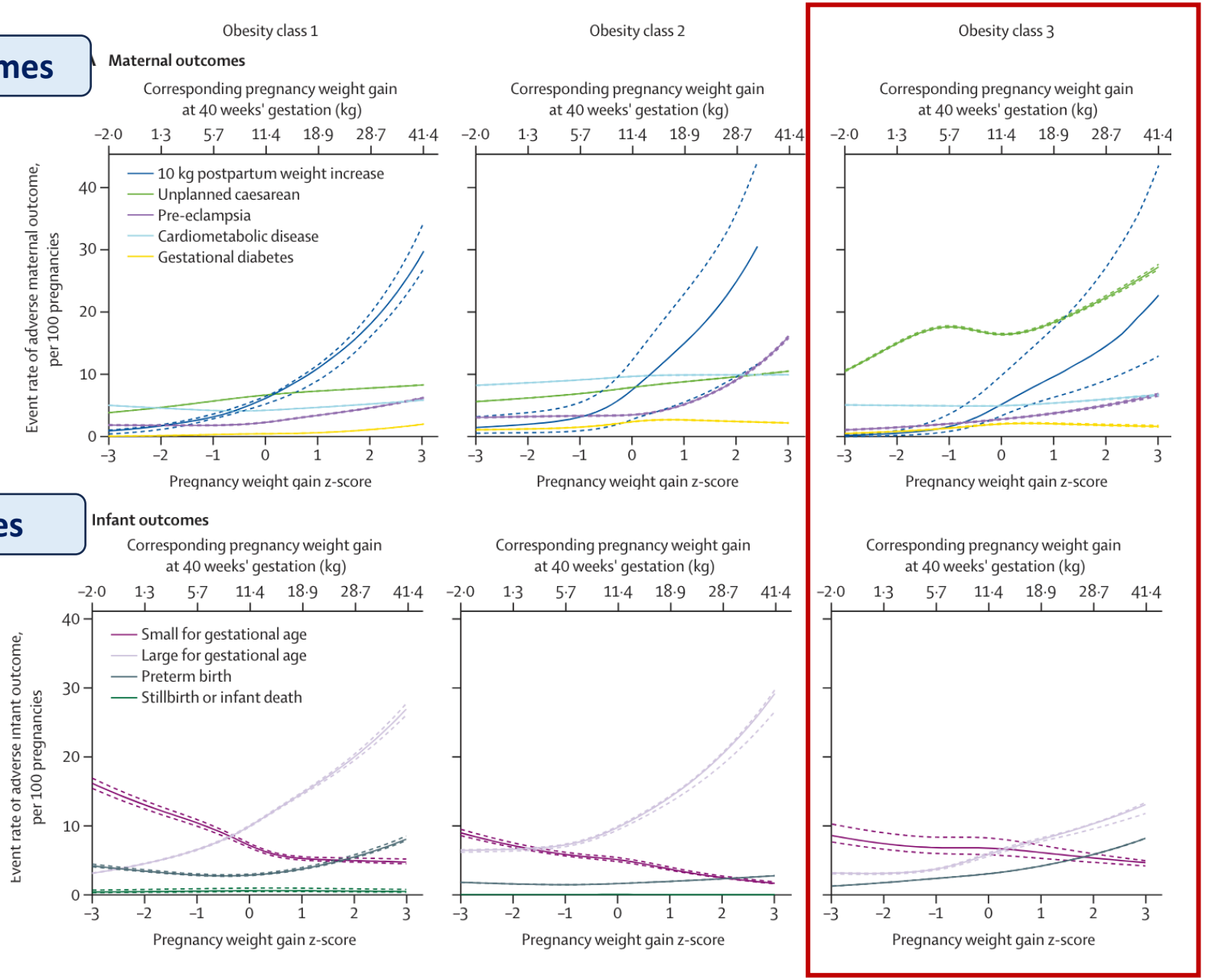
(stillbirth, infant death, large for gestational age and small for gestational age at birth, preterm birth, unplanned caesarean delivery, gestational diabetes, pre-eclampsia, excess postpartum weight retention, and new-onset longer-term maternal cardiometabolic disease after pregnancy, weighted to account for event severity)

	Obesity class 1 (n=11 667)	Obesity class 2 (n=3160)	Obesity class 3 (n=933)
Prepregnancy comorbidity			
Cardiovascular disease	837 (7·2%)	286 (9·1%)	116 (12·4%)
Diabetes	157 (1·3%)	58 (1·8%)	28 (3·0%)
Gestational age at delivery, days	278 (13)	277 (15)	277 (14)
Gestational weight gain			
Number of measurements per individual‡	5 (4–7)	6 (4–8)	6 (4–8)
Weight gain§, kg	10·7 (6·0)	8·7 (6·2)	7·2 (6·2)
Weight gain, z-score¶	0·02 (1·00)	−0·37 (1·17)	−0·65 (1·32)
Gestational weight gain based on IOM recommendations (5–9 kg)			
Below	1623 (13·9%)	786 (24·9%)	310 (33·2%)
Within	3604 (30·9%)	1040 (32·9%)	310 (33·2%)
Above	6440 (55·2%)	1334 (42·2%)	313 (33·5%)

Johansson et al, Lancet, 2024

Maternal outcomes

Infant outcomes



In pregnancies with class 3 obesity, **weight gain values below the IOM limit or weight loss** were **associated** with **reduced risk** of the adverse composite outcome (adjusted RR 0·81 [0·71–0·89] at weight gain z-score –2·4, or 0 kg).

Calls to lower or remove the lower limit of current IOM recommendations for pregnant women with obesity, and suggest that separate guidelines for class 3 obesity might be warranted. *Johansson et al, Lancet, 2024*

GLYCEMIC TARGETS

MONITORAGGIO CLINICO

HbA1c:

normali o più possibile vicini alla norma (**≤48** mmol/mol, **≤6,5**%), **in assenza o limitando al massimo le ipoglicemie**

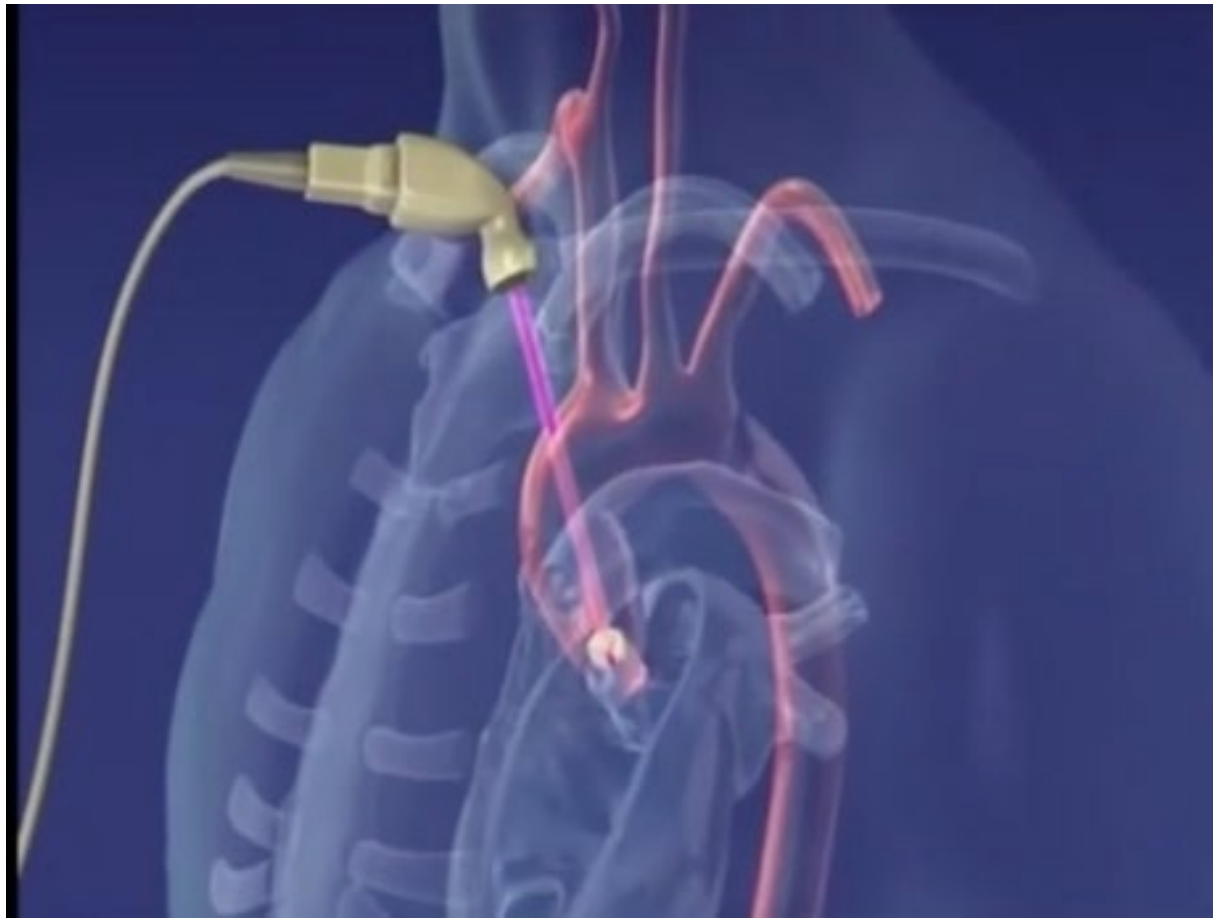
Profili glicemici:

- **≤ 90** mg/dl a digiuno
- **≤130** mg/dl un'ora dopo i pasti
- **≤120** mg/dl 2 ore dopo i pasti

HAEMODINAMICS

MONITORAGGIO CLINICO

USCOM – ULTRASONIC CARDIAC OUTPUT MONITOR



- Cardiac output (CO),
- Cardiac index (CI),
- Stroke volume (SV),
- Total vascular resistance (TVR),
- Inotropy index (INO)
- Potential to kinetic energy ratio (PKR)

MONITORAGGIO CLINICO-ECOGRAFICO

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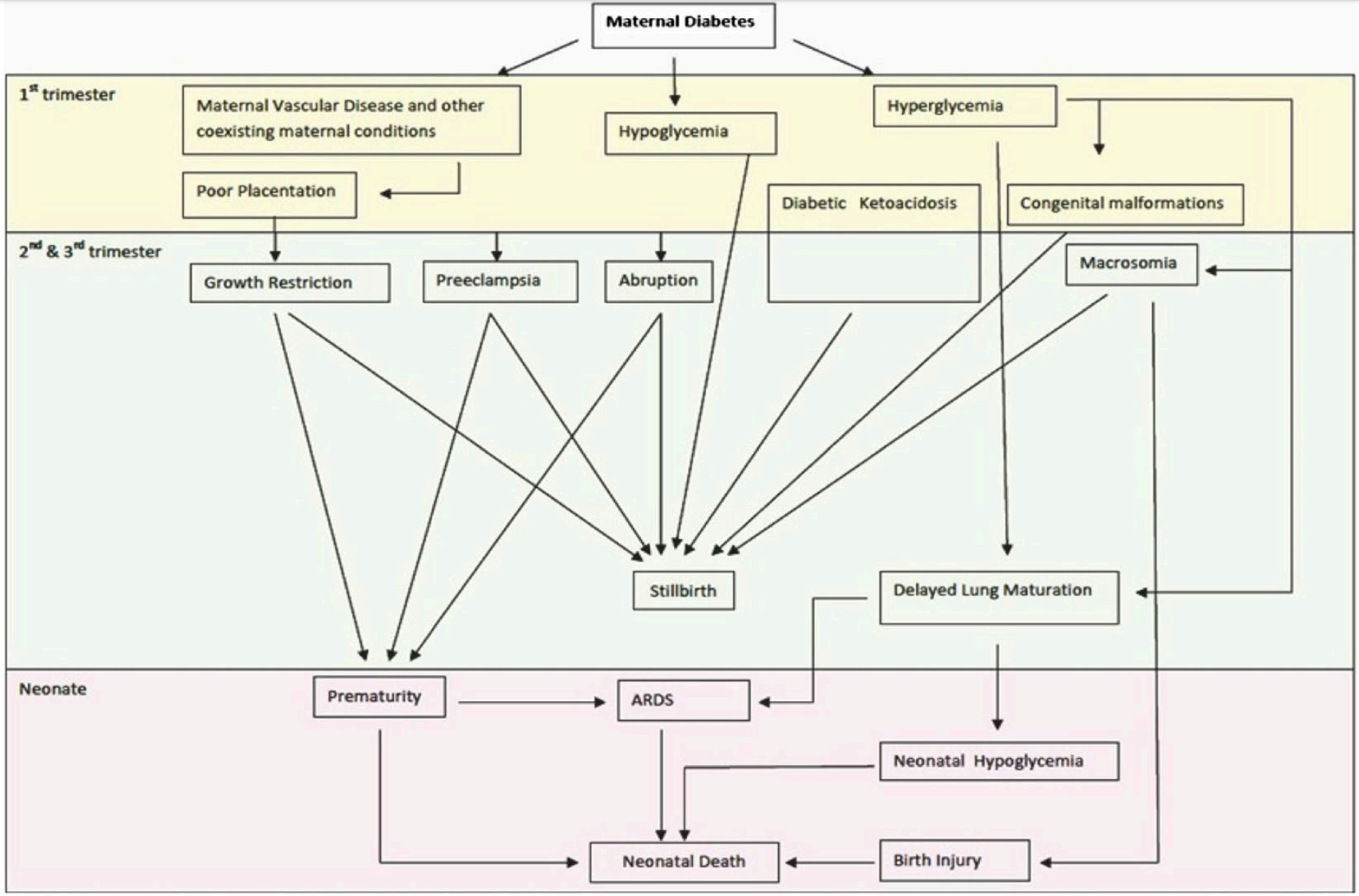
MONITORAGGIO ECOGRAFICO



Starikov R et al, Curr Diab Rep 2015

MONITORAGGIO ECOGRAFICO

PLACENTAL VASCULAR SUPPLY

TROPHOBLASTIC INVASION

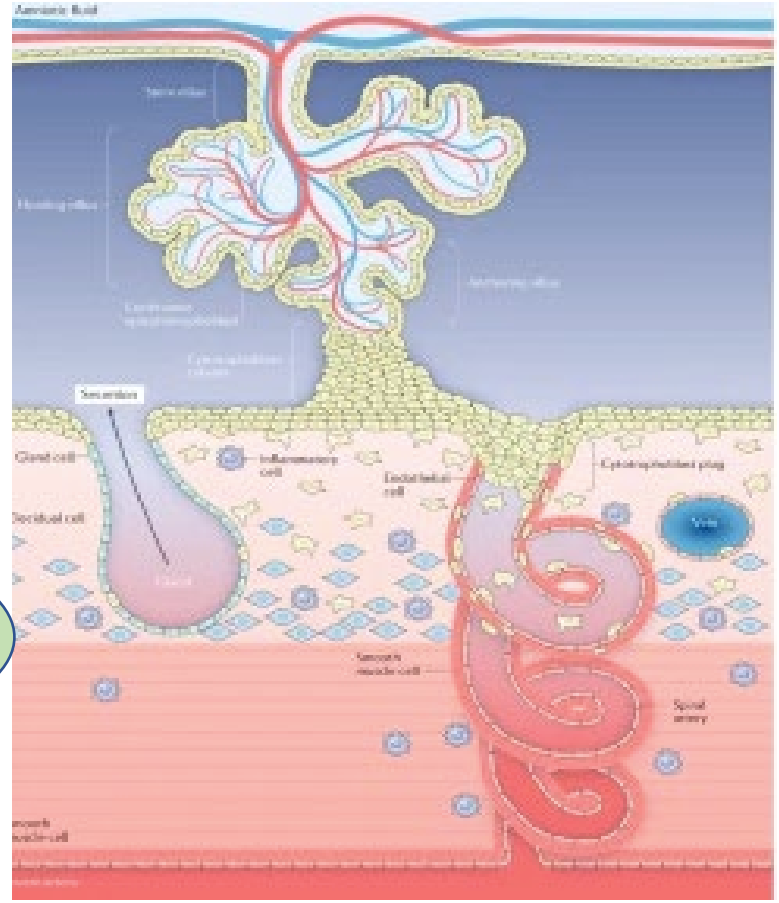
MATERNAL COMPARTMENT

- ✓ Volume expansion
- ✓ Increased substrate availibity
- ✓ Reduced vascular reactivity

ADHERENCE → **ENDOCRINE SIGNALS** → **INCREASED SUBSTRATE TRANSPORTERS**

FETAL COMPARTMENT

VILLOUS BRANCHING



I TRIMESTER | II TRIMESTER | III TRIMESTER

Aplin DJ, Natur Rev Endocrinol, 2020

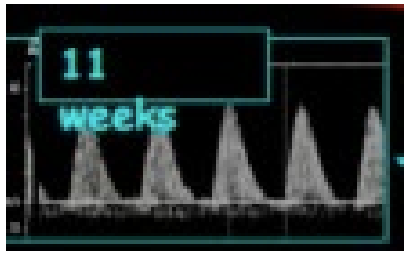
MONITORAGGIO ECOGRAFICO

VELOCIMETRIA DOPPLER

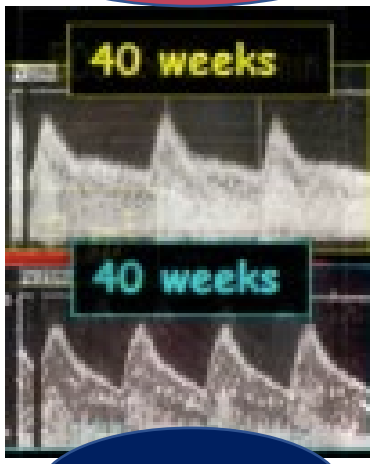
MATERNAL COMPARTMENT

High resistency → Low resistency

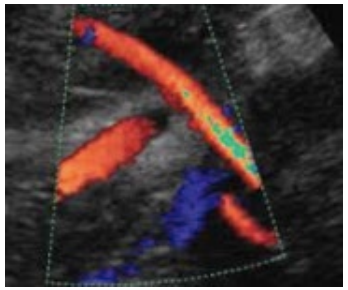
FETAL COMPARTMENT

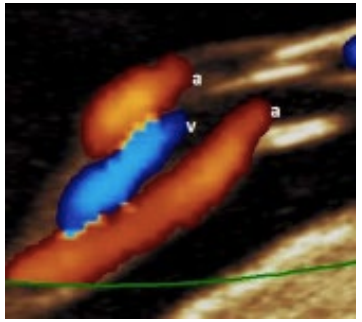


500-600ml/min



12m²



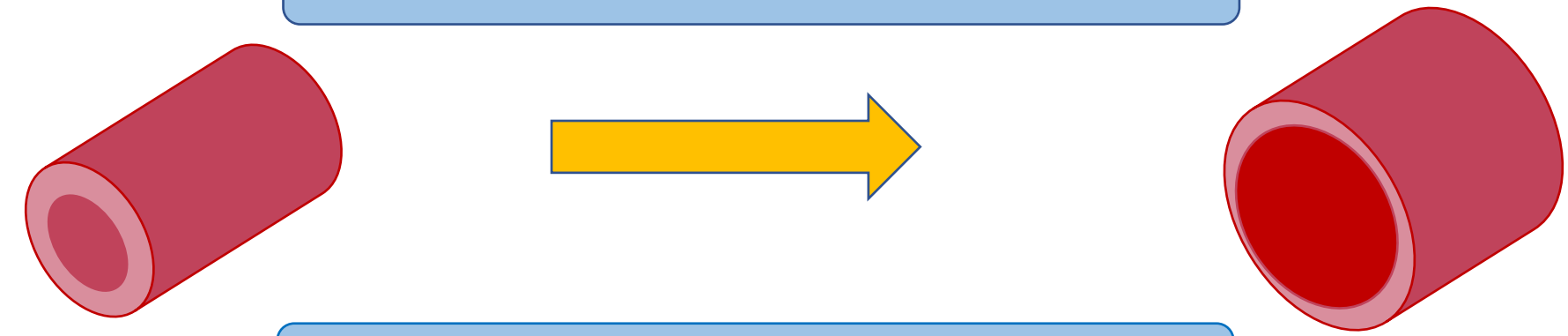


I TRIMESTER | II TRIMESTER | III TRIMESTER

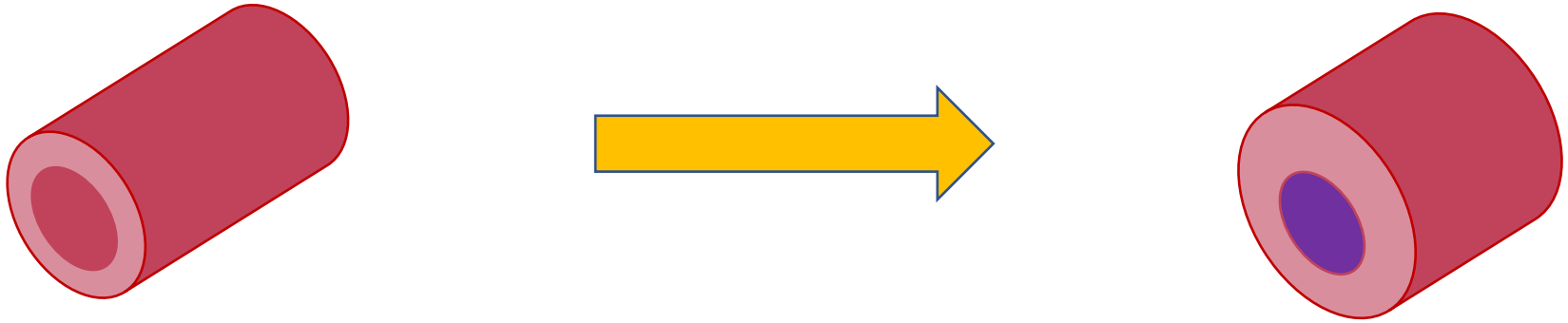
MONITORAGGIO ECOGRAFICO

The Diabetic Placenta

HYPERGLYCEMIA

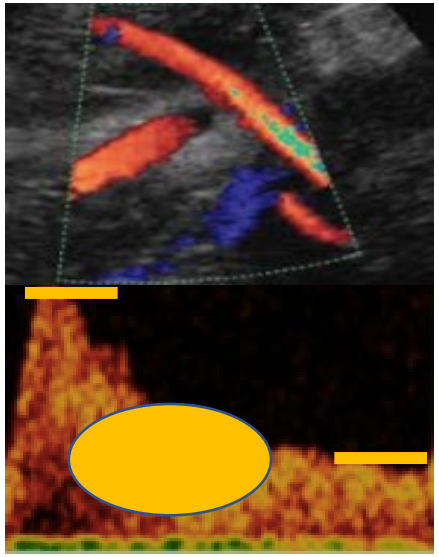


VASCULOPATHY

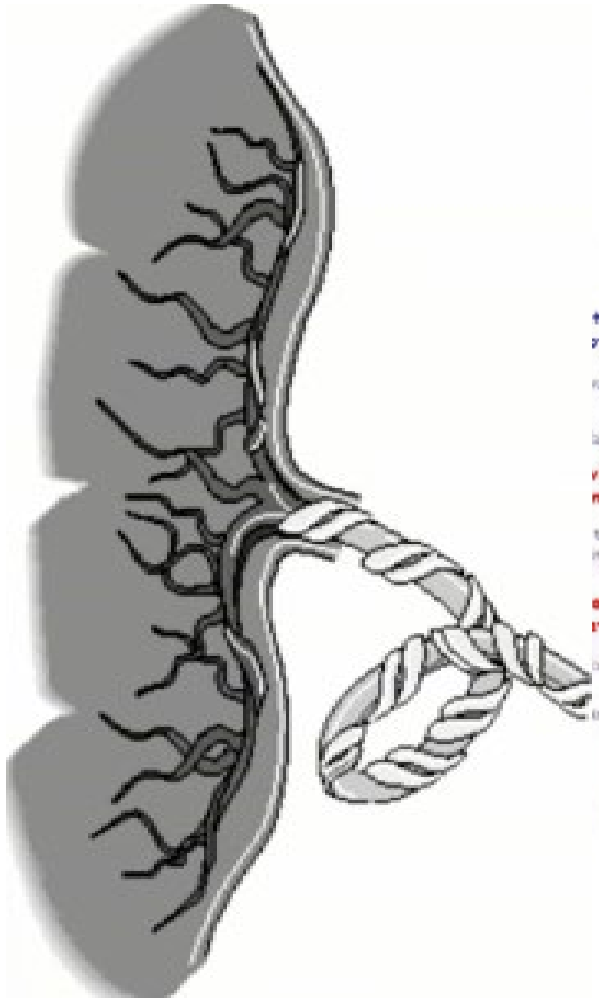


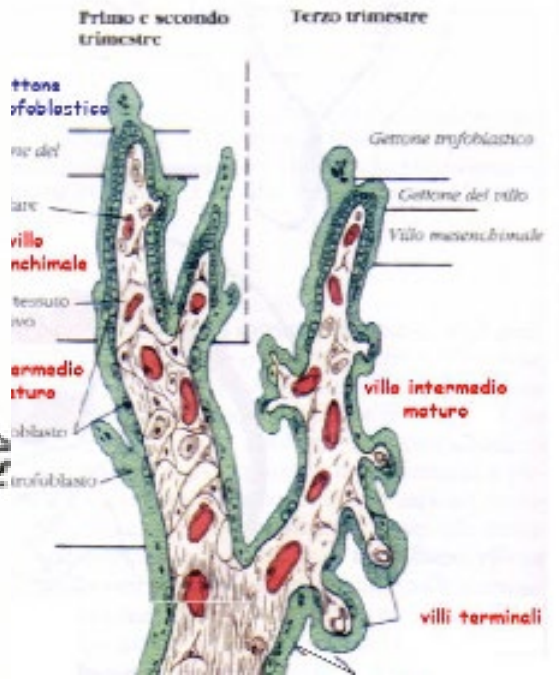
MONITORAGGIO ECOGRAFICO

MOTHER

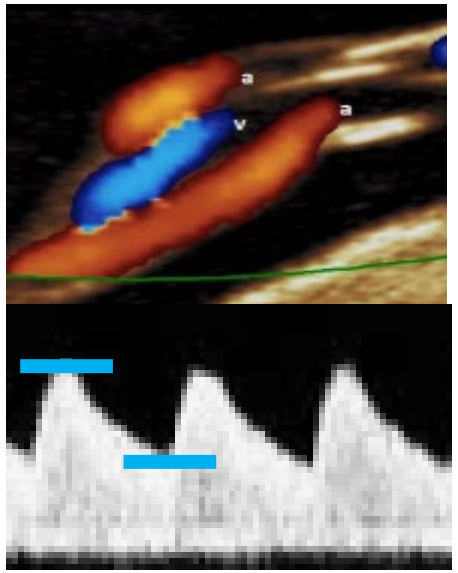


Spiral artery vascular resistency Downstream vascular resistence





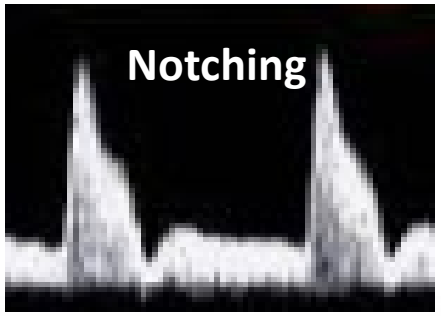
FETUS

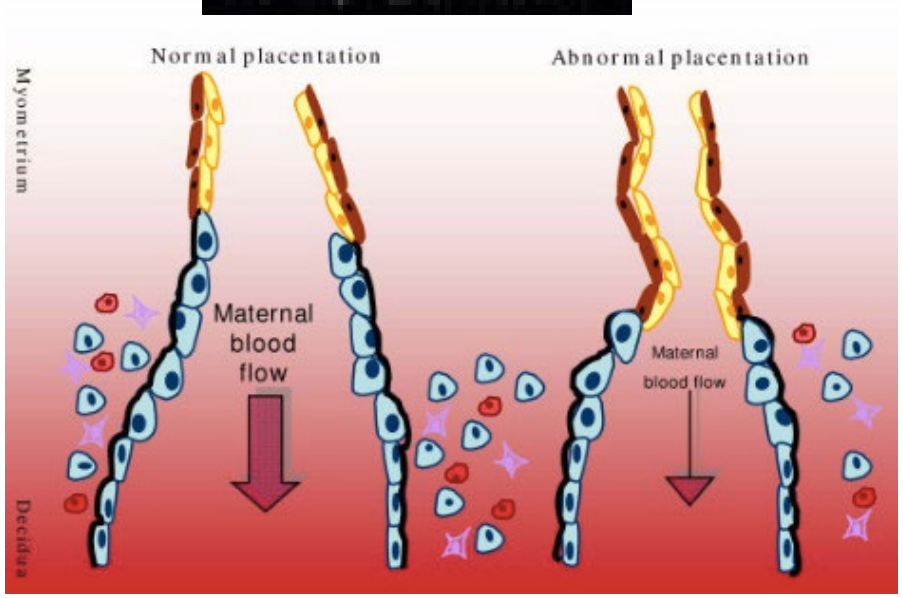


Villous Cross-sectional area & vascular resistance

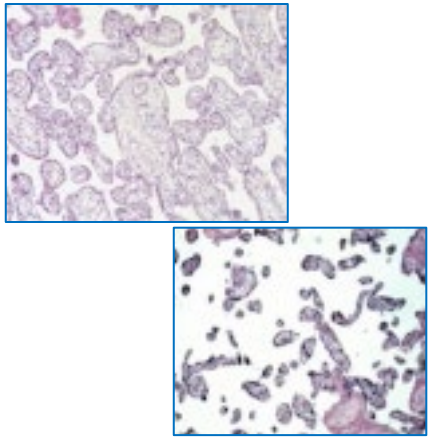
MONITORAGGIO ECOGRAFICO

MOTHER





VELOCIMETRIA DOPPLER



Abnormal villous tree
40-100% FGR

ADVERSE OUTCOMES:
- ✓ Hypoxemia/Acidemia
- ✓ Stillbirth
- ✓ Preterm birth
- ✓ Neonatal complications
- ✓ Poor development

FETUS

PI

AED

REDV

ANATOMY

MONITORAGGIO ECOGRAFICO

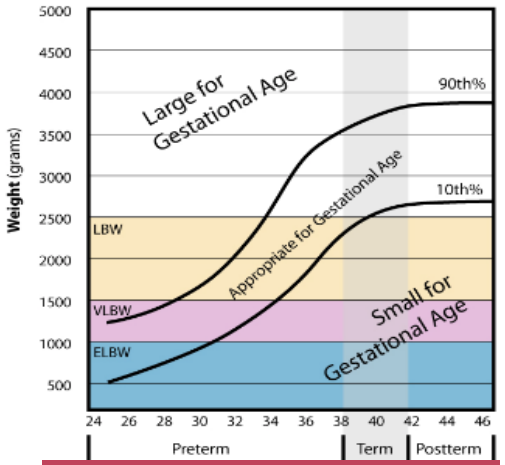
Gestational Age Specific Target

BIRTH DEFECTS

VASCULOPATHY

BIRTH DEFECTS

FETAL GROWTH



STILLBIRTH

I TRIMESTER | II TRIMESTER | III TRIMESTER

MONITORAGGIO ECOGRAFICO

I TRIMESTER

NICE National Institute for Health and Care Excellence

BIRTH DEFECTS

VASCULOPATHY

To confirm the viability of the pregnancy and gestational age at 7 to 9 weeks.

PREVENTING PRE-ECLAMPSIA

For guidance on using antiplatelet agents to reduce the risk of pre-eclampsia in pregnant women with diabetes **[2015]**

DETECTING CONGENITAL MALFORMATIONS

Offer women with diabetes an ultrasound scan at 20 weeks to detect fetal structural abnormalities, including examination of the fetal heart (4 chambers, outflow tracts and 3 vessels). **[2008, amended 2015]**

NICE, Diabetes in Pregnancy, 2015, Last update 2020

MONITORAGGIO ECOGRAFICO

11-14 weeks

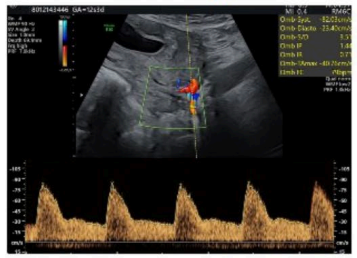
Risk assessment

Risk for preeclampsia

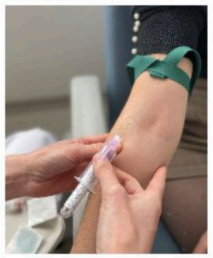
The Fetal Medicine Foundation

Clinical parameters

Uterine Doppler



Biomarkers



Medical history

Chronic hypertension	○ Yes	○ No
Diabetes type I	○ Yes	○ No
Diabetes type II	○ Yes	○ No
Systemic lupus erythematosus	○ Yes	○ No
Anti-phospholipid syndrome	○ Yes	○ No

Ultrasound Obstet Gynecol 2023; **61**: 127–143
Published online in Wiley Online Library (wileyonlinelibrary.com). **DOI:** 10.1002/uog.26106

isuog.org GUIDELINES

ISUOG Practice Guidelines (updated): performance of 11–14-week ultrasound scan

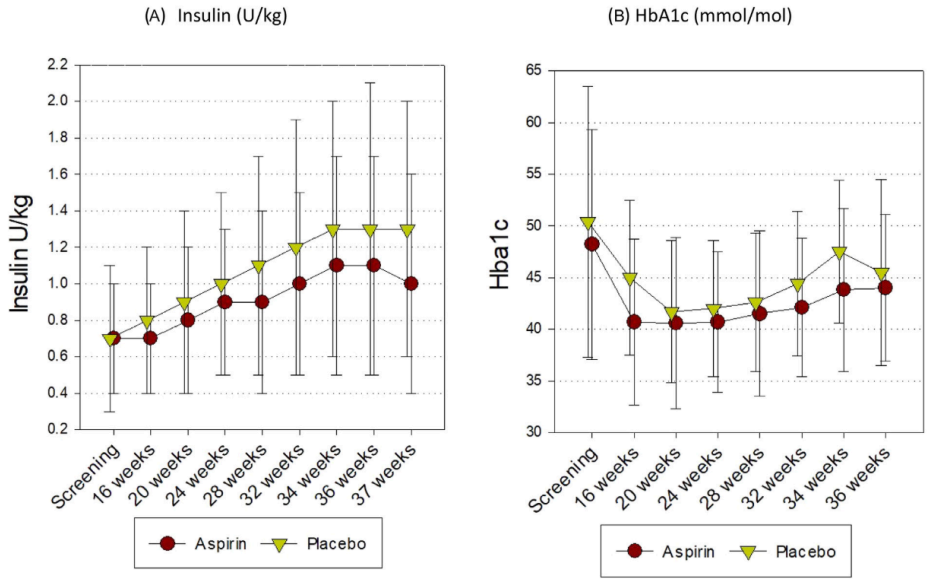
Table 4 Screening for pre-eclampsia: maternal factors

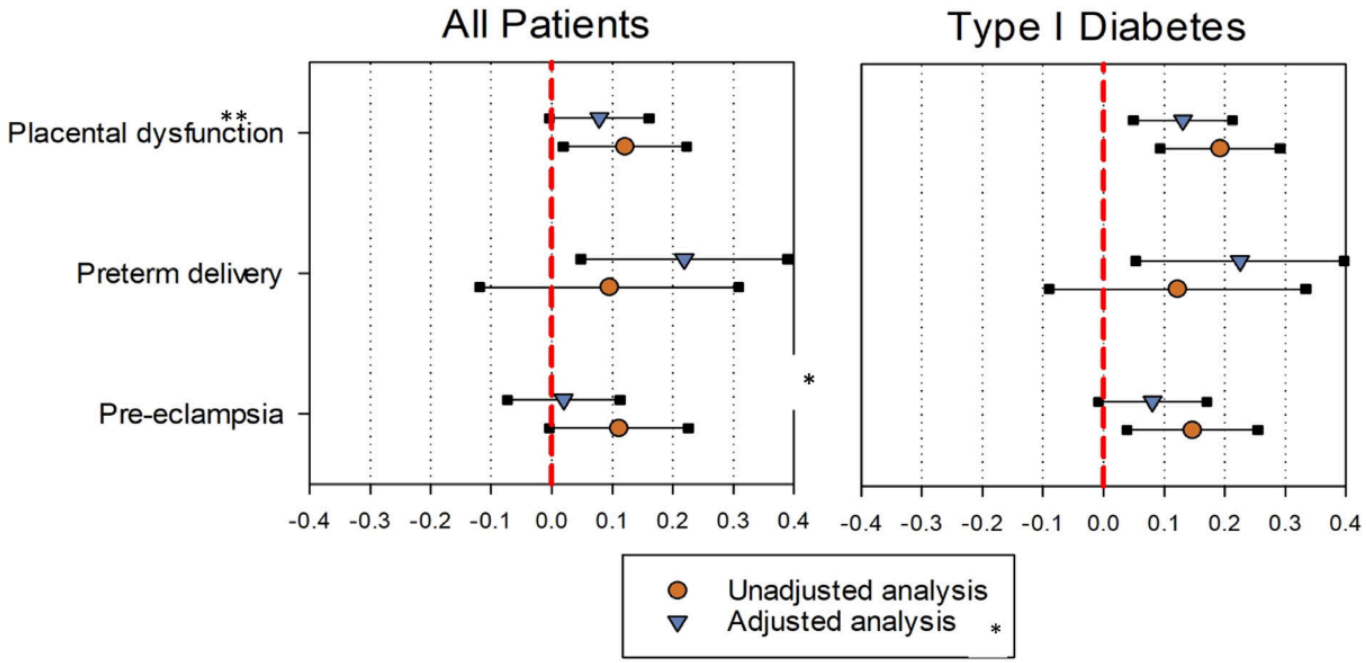
Medical history
Smoking habit
History of chronic hypertension
History of diabetes mellitus: Type 1, Type 2, insulin intake
History of systemic lupus erythematosus or antiphospholipid syndrome

The IRELAnD study—investigating the role of early low-dose aspirin in diabetes mellitus: a double-blinded, placebo-controlled, randomized trial

Catherine Finnegan, PhD; Patrick Dicker, MSc; Denisa Asandei, MPhil; Mary Higgins, MD; Neil O'Gorman, MD; Mairead O' Riordan, MRCOG; Fidelma Dunne, PhD; Geraldine Gaffney, MD; Christine Newman, MD; Fionnuala McAuliffe, FRCOG; Vineta Ciprike, MD; Elena Fernandez, MS; Fergal D. Malone, MD; Fionnuala M. Breathnach, MD

- ✓ Women with T1DM or T2DM
- ✓ 67 patients randomized to aspirin and 67 to placebo
- ✓ 150-mg daily aspirin vs. placebo
- ✓ 11 -14 weeks' gestation until 36 weeks.





(*) Adjusted analysis: adjusted for baseline insulin use. (**) Placental dysfunction: composite outcome of any of the following: preeclampsia, preterm birth <34 weeks of gestation, fetal growth restriction <10th percentile, or stillbirth.

Finnegan. The IRELAnD study. Am J Obstet Gynecol MFM 2024.

Beneficial effect of aspirin on glycemic control

No reduction of the risk of adverse perinatal outcome

MONITORAGGIO ECOGRAFICO

11-14 weeks

Ultrasound Obstet Gynecol 2023; **61**: 127–143
Published online in Wiley Online Library (wileyonlinelibrary.com). **DOI:** 10.1002/uog.26106

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GUIDELINES

ISUOG Practice Guidelines (updated): performance of 11–14-week ultrasound scan

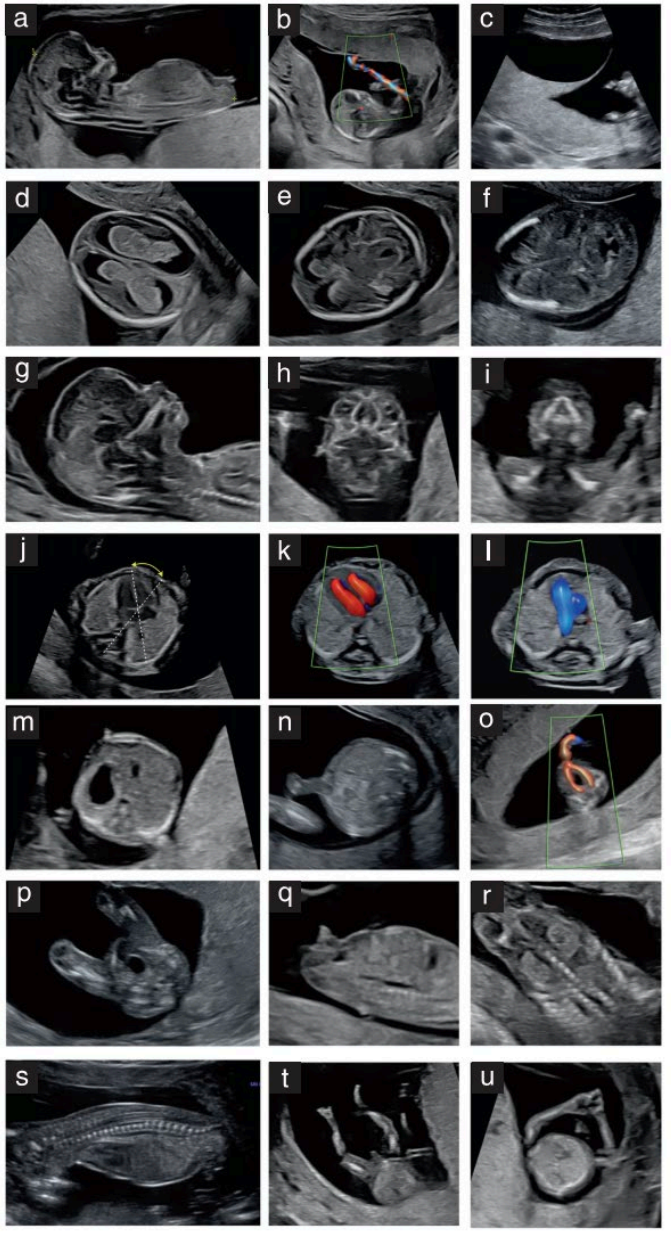


Table 1 Minimum requirements for scan at 11 + 0 to 14 + 0 weeks' gestation

Anatomical region	*Minimum requirements for scan*
General	Confirm singleton pregnancy
Head and brain	Axial view of head: Calcification of cranium Contour/shape of cranium (with no bony defects) Two brain halves separated by interhemispheric falx Choroid plexuses almost filling lateral ventricles in their posterior two-thirds (butterfly sign)
Neck	Sagittal view of head and neck: Confirm whether nuchal translucency thickness < 95th percentile
Heart	Axial view of heart at level of four-chamber view: Heart inside chest with regular rhythm
Abdomen	Axial view: Stomach visible Intact abdominal wall Axial or sagittal view: Bladder visible and not dilated
Extremities	Visualize four limbs, each with three segments
Placenta	Ascertain normal appearance without cystic structures
Biometry	Sagittal view: Crown–rump length and nuchal translucency thickness Axial view: Biparietal diameter

MONITORAGGIO ECOGRAFICO

II TRIMESTER

BIRTH DEFECTS

SIEOG

ECOGRAFIA DI RIFERIMENTO

Sistema nazionale per le Linee Guida

Indicazioni all'ecografia di riferimento

Indicazioni familiari	■ Precedente gravidanza con feto affetto da malformazione congenita ■ Malattie genetiche ereditarie associate a malformazioni (quando non escluse da *test* genetici prenatali)
Indicazioni materne	■ BMI pregravidico >40 kg/m^2 ■ Diabete (tipo 1 e 2) pregestazionale o diabete manifesto diagnosticato entro il I trimestre di gravidanza ■ Infezioni materne da Rosolia, Toxoplasma, CMV, Parvovirus B19, Varicella, HIV ■ Assunzione di farmaci in gravidanza (carbamazepina, levetiracetam, oxcarbazepina, fenobarbitale, fenitoina, topiramato, valproato, politerapie con anticonvulsivanti, paroxetina, fluoxetina, Propiltiouracile + metimazoloicarbimazolo) ■ Esposizione a radiazioni ionizzanti (previa valutazione da parte dello specialista in fisica medica della dose assorbita dal nascituro) ■ Condizioni a rischio per anemia fetale (infezione da Parvovirus B19, *test* di Coombs indiretto positivo a titolo elevato, feto affetto o a rischio di malattie genetiche associate ad anemia fetale)
Indicazioni fetali	■ Sospetta malformazione congenita agli esame ecografici di screening ■ NT ≥3,5 mm (99°centile) ■ Iposviluppo fetale precoce

SIEOG, Linee Guida, 2021
https://www.sieog.it/wp-content/uploads/2022/07/documento-eco-riferimeto-def-NV-2.pdf

MONITORAGGIO ECOGRAFICO

II TRIMESTER

SIEOG

BIRTH DEFECTS

PRENOTAZIONE DEGLI ESAMI ECOGRAFICI DI RIFERIMENTO:

U (tempo massimo di attesa 72 ore) con le seguenti indicazioni:

a) sanguinamenti in gravidanza;
b) sospetta anomalia strutturale fetale;
c) altre condizioni che il medico prescrittore decide di attribuire a questa classe di priorità.

B (entro 10 giorni) con le seguenti indicazioni:

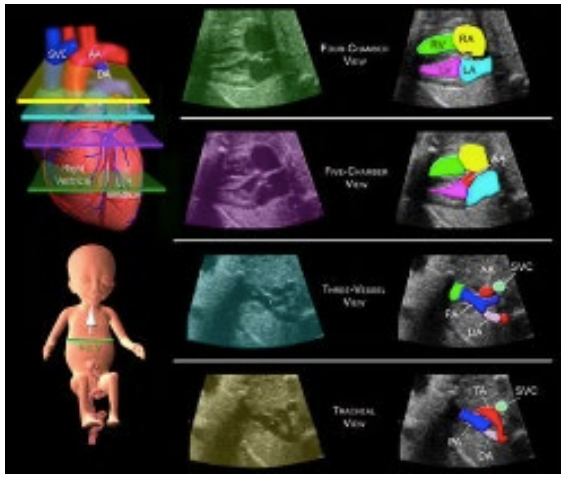
a) sospetto ritardo di crescita fetale;
b) sospetta macrosomia;
c) sospetta placenta previa;
d) condizioni che il medico prescrittore decide di attribuire a questa classe di priorità.

SIEOG, Linee Guida, 2021
https://www.sieog.it/wp-content/uploads/2022/07/documento-eco-riferimeto-def-NV-2.pdf

MONITORAGGIO ECOGRAFICO

II TRIMESTER

CONGETINAL HEART DEFECTS DEFECTS



ECOCARDIOGRAFIA

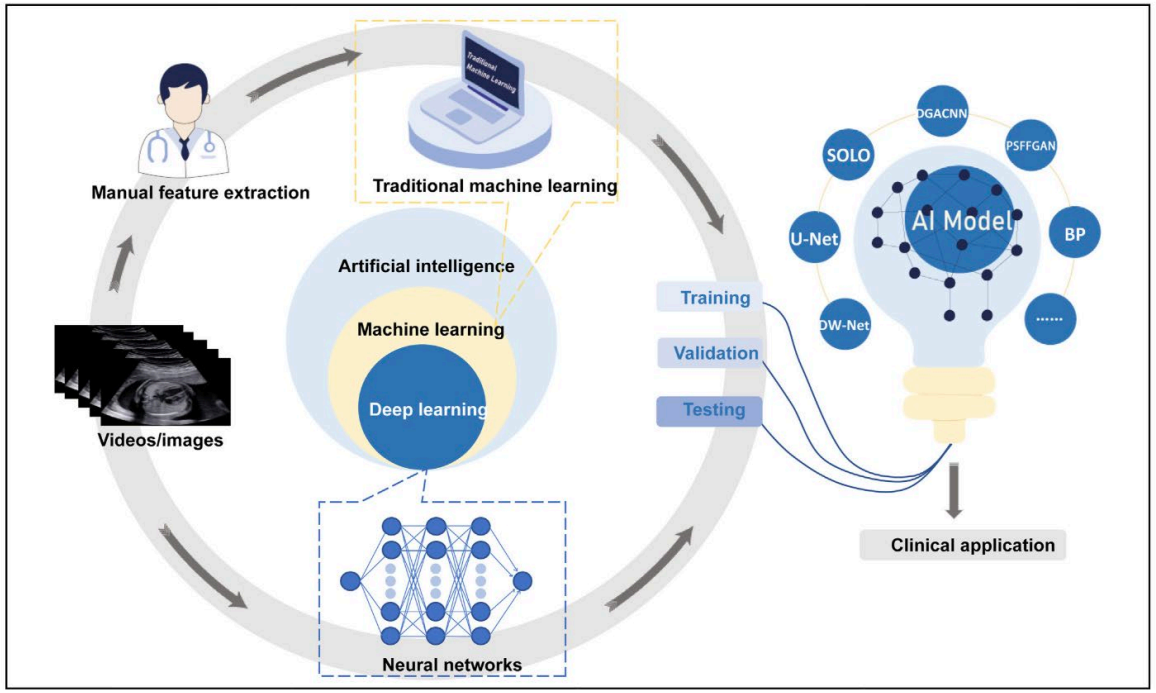
- ✓ **Congenital heart disease** (CHD) is an important complication of gestational diabetes mellitus (GDM) and pregestational DM with a **4-fold increased risk**, ***irrespective*** of the type of antidiabetic treatment received
- ✓ The cardiac development occurs in the first trimester and is **almost completed by 6 weeks**
- ✓ Other cardiac diseases, such as hypertrophic cardiomyopathy and decreased cardiac performance due to functional abnormalities

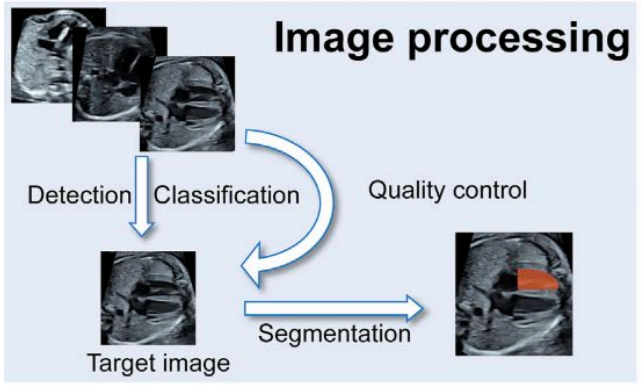
MONITORAGGIO ECOGRAFICO

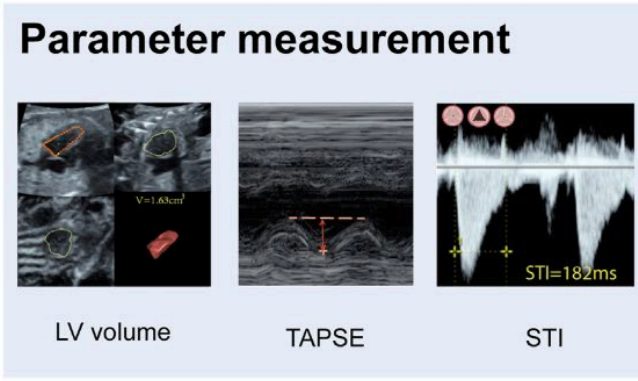
STATE-OF-THE-ART REVIEW

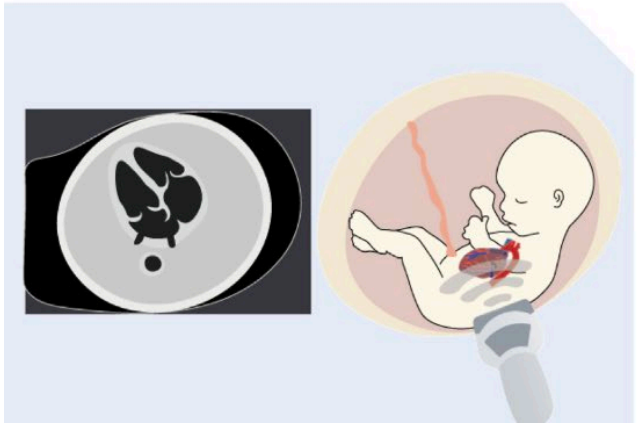
Advances in the Application of Artificial Intelligence in Fetal Echocardiography

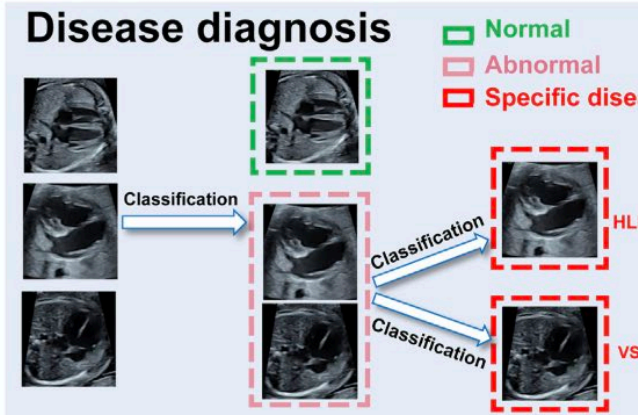
Junmin Zhang, MD, Sushan Xiao, MD, Ye Zhu, MS, Zisang Zhang, MD, Haiyan Cao, MD, Mingxing Xie, MD, PhD, and Li Zhang, MD, PhD, *Wuhan, China*









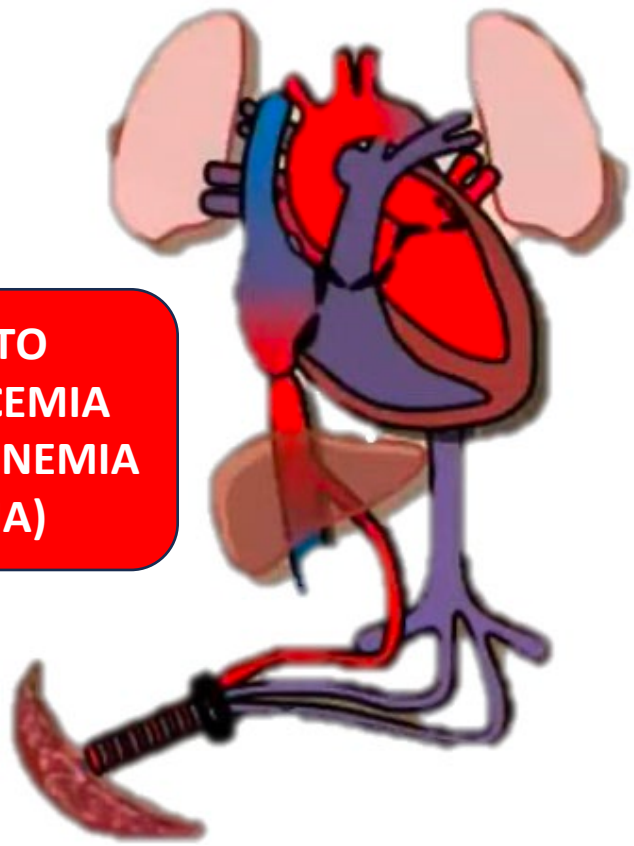


Artificial intelligence technology has great potential **to empower sonographers in time-saving and accurate diagnosis** and to bridge the skill gap **in different regions**.

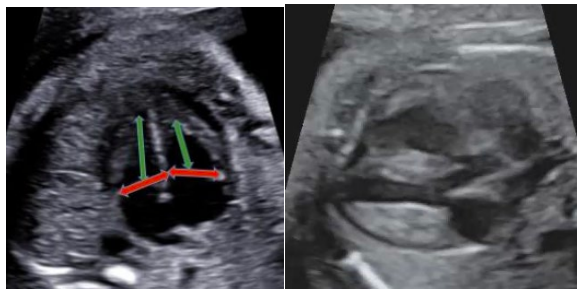
MONITORAGGIO ECOGRAFICO

ECOCARDIOGRAFIA FUNZIONALE

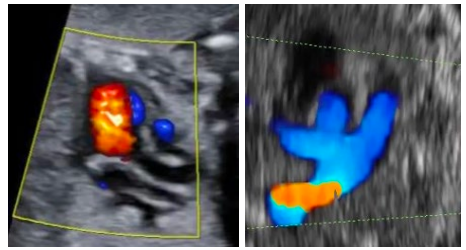
INSULTO (IPERGLICEMIA IPERINSULINEMIA IPOSSIA)



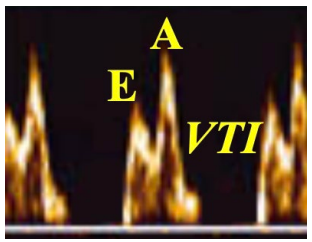
RIMODELLAMENTO → **FORMA**, **DIMENSIONE**

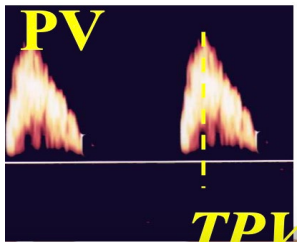


RIDISTRIBUZIONE → **RIGHT CARDIAC OUTPUT**, **LEFT CARDIAC OUTPUT**



DISFUNZIONE → **SISTOLICA**, **DIASTOLICA**





Danno diretto/ tossicità del miocardio → Perdita/danno cellulare e riduzione della contrattilità → Ipertrofia miocardica compensatoria

MONITORAGGIO ECOGRAFICO

J Diabetes Complications. 2022 Jan;36(1):108079. doi: 10.1016/j.jdiacomp.2021.108079. Epub 2021 Oct 21.

Persistent subclinical myocardial dysfunction among infants of diabetic mothers

Jyothi Samanth [1], R Padmakumar [2], Akhila Vasudeva [3], Leslie Lewis [4], Krishnananda Nayak [5], Vidya Nayak [6]

At the first week of life, at 6-weeks, and 6-months of life

BJOG. 2021 Jan;128(2):272-279. doi: 10.1111/1471-0528.16434. Epub 2020 Aug 26.

Cardiac function in gestational diabetes mellitus: A longitudinal study from fetal life to infancy

J Aguilera [1], J Semmler [1], S Anzoategui [1], H Zhang [1], K H Nicolaides [1], M Charakida [1 2]

At 12-months of life

Observational Study. Pediatr Res. 2023 Sep;94(3):996-1002. doi: 10.1038/s41390-023-02566-6. Epub 2023 Mar 18.

Impaired myocardial deformation persists at 2 years in offspring of mothers with diabetes mellitus

Xander Jacquemyn [1 2], Shelby Kutty [1], Preeta Dhanantwari [3], William J Ravekes [1], Aparna Kulkarni [4]

At 2-years of life

MONITORAGGIO ECOGRAFICO

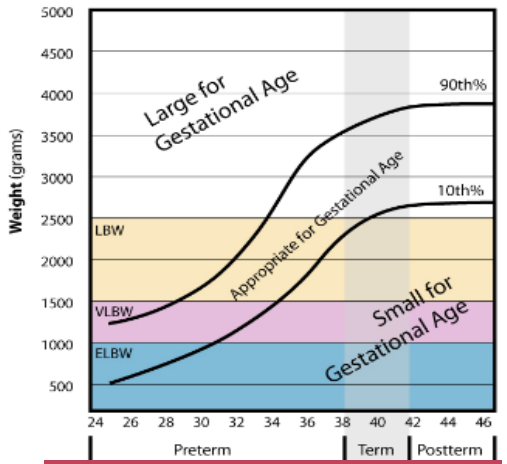
GROWTH

III TRIMESTER

Gestational Age Specific Target

MONITORING FETAL GROWTH AND WELLBEING

FETAL GROWTH



STILLBIRTH

Offer pregnant women with diabetes ultrasound monitoring of fetal growth and amniotic fluid volume **every 4 weeks from 28 to 36 weeks.** **[2008]**

Routine monitoring of fetal wellbeing before 38 weeks is not recommended in pregnant women with diabetes, unless there is a **risk of fetal growth restriction.** This includes methods such as fetal umbilical artery doppler recording, fetal heart rate recording and biophysical profile testing. **[2008, amended 2015]**

Provide an **individualised approach** to monitoring fetal growth and wellbeing for women with diabetes and a risk of fetal growth restriction (macrovascular disease or nephropathy). **[2008, amended 2015]**

NICE, Diabetes in Pregnancy, 2015, Last update 2020

MONITORAGGIO ECOGRAFICO

GROWTH

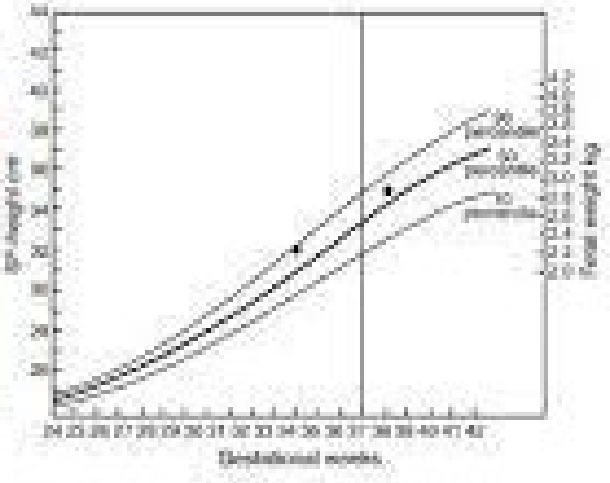
III TRIMESTER

Valutazione soggettiva

- Manovre di Leopold
- Valutazione della donna

Valutazione oggettiva

- Distanza Sinfisi-Fondo (SFH)
- US - EFW



MONITORAGGIO ECOGRAFICO

RUOLO ECOGRAFIA DIBATTUTO: DIAGNOSI PRENATALE È IMPRECISA

- Studi differenti / grande eterogeneità
- Differenti GA di predizione
- Numeri casi analizzati
- Intervallo tra ecografia e parto
- AC e EFW spesso utilizzati
- Formule per la stima del peso
- DR tra 12% e 75% con range FP 1-32%

«Diagnosi accurata di macrosomia eseguita solo pesando il feto alla nascita»

MONITORAGGIO ECOGRAFICO

MONITORING FETAL GROWTH

Definizione	**MACROSOMIA** Non consenso unanime	**LARGE FOR GESTATIONAL AGE (LGA)** Peso alla nascita ≥ 90° percentile per epoca gestazionale **FETAL GROWTH RESTRICTION (FGR)** Delphy Consensus, 2016
Formule	**FORMULE PER LA STIMA DEL PESO**	• **4000 g** → maggiori rischi in travaglio • **4500 g** →predittivo di morbilità • **5000 g** →indicatore di rischio di mortalità
Curve	**CURVE DI RIFERIMENTO**	

Peso come Indicatore di Rischio

Boulet SL et al , AJOG, 2003

MONITORAGGIO ECOGRAFICO

Archives of Gynecology and Obstetrics
https://doi.org/10.1007/s00404-018-4934-y

MATERNAL-FETAL MEDICINE

Sonographic prediction of macrosomia in pregnancies complicated by maternal diabetes: finding the best formula

Anat Shmueli[1,2] · Lina Salman[1,2] · Eran Hadar[1,2] · Amir Aviram[2,3] · Ron Bardin[1,2] · Eran Ash
Rinat Gabbay-Benziv[4,5]

- Retrospettivo:
- 1060 biometrie fetali entro 7 giorni dal parto 37-42w
- **Hadlock's formula (1985) (BPD, CC, AC, FL) miglior predizione**
- Sensibilità tutte le formule 51.5% e specificità 92
- Distanza euclidiana (media geometrica dell'errore random e sistematico) più bassa miglior predizione

Table 1 Sonographic fetal weight estimation formulas

Formula#	Reference	Equation	
1	Hadlock et al. [23]	$=10^{1.304+0.05281(AC)+0.1938(FL)-0.004(AC)(FL)}$	AC and FL
2	Hadlock et al. [23]	$=10^{1.335-0.0034(AC)(FL)+0.0316(BPD)+0.0457(AC)+0.1623(FL)}$	AC, FL and BPD
3	Hadlock et al. [26]	$=10^{1.1134+0.05845(AC)-0.000604(AC)2-0.007365(BPD)2+0.000595(BPD)(AC)+0.1694(BPD)}$	AC and BPD
4	Jordaan [25]	$=10^{0.9119+0.488(HC)+0.0824(AC)-0.001599(HC)(AC)}$	AC and HC
5	Hadlock et al. [23]	$=10^{1.326-0.00326(AC)(FL)+0.0107(HC)+0.0438(AC)+0.158(FL)}$	AC, FL and HC
6	Hsieh et al. [27]	$=10^{2.1315+0.0056541(AC)(BPD)-0.00015515(BPD)(AC)2+0.000019782(AC)3+0.052594(BPD)}$	AC and BPD
7	Shepard et al. [24]	$=10^{-1.7492+0.166(BPD)+0.046(AC)-0.002546(AC)(BPD)}$	AC and BPD
8	Jordaan [25]	$=10^{-1.1683+0.0377(AC)+0.0950(BPD)-0.0015(BPD)(AC)}$	AC and BPD
9	Hadlock et al. [23]	$=10^{1.3596+0.0064(HC)+0.0424(AC)+0.174(FL)+0.00061(BPD)(AC)-0.00386(AC)(FL)}$	AC, FL, BPD and HC
10	Shinozuka et al. [28]	$=0.23966(AC)2(FL)+1.6230(BPD)3$	AC, FL and BPD

AC abdominal circumference, *HC* head circumference, *BPD* biparietal diameter, *FL* femur length

Ranking[a]	Number	Formula	Biometry	Euclidean distance
1	9	Hadlock et al. [23]	AC, FL, BPD and HC	6.60
2	5	Hadlock et al. [23]	AC, FL and HC	6.66
3	10	Shinozuka et al. [28]	AC, FL and BPD	6.76
4	8	Jordaan [25]	AC and BPD	7.08
5	6	Hsieh et al. [27]	AC and BPD	7.32
6	3	Hadlock et al. [26]	AC and BPD	7.37
7	4	Jordaan [25]	AC and HC	8.68
8	2	Hadlock et al. [23]	AC, FL and BPD	8.70
9	7	Shepard et al. [24]	AC and BPD	11.41
10	1	Hadlock et al. [23]	AC and FL	18.47

MONITORAGGIO ECOGRAFICO

Fetal Growth Curves

Is There a Universal Reference?

Katherine L. Grantz, MD, MS

Obstet Gynecol Clin N Am 48 (2021) 281–296
https://doi.org/10.1016/j.ogc.2021.02.003

- 3 modern cohort studies have an advantage over historical fetal growth references because they included **diverse populations**.
- Fetuses as being **classified** below or above a cutoff point.
- It is important to know **how a growth reference performs in a local population** in relation to fetal morbidity and mortality when implementing in clinical practice.

Table 2
Fiftieth percentiles for fetal anthropometric measurements by gestational age for the 3 studies[a]

	Estimated Fetal Weight [c] (g), Fiftieth Percentiles					
Gestational Age (wk) [b]	NICHD White	NICHD Hispanic	NICHD Asian	NICHD Black	INTERGROWTH	WHO Fetal
24	674	651	640	647	668	665
25	787	758	745	751	756	778
26	912	876	862	866	856	902
27	1050	1007	990	994	969	1039
28	1202	1151	1132	1134	1097	1189
29	1369	1311	1287	1289	1239	1350
30	1552	1486	1456	1459	1396	1523
31	1749	1676	1637	1642	1568	1707
32	1960	1879	1830	1837	1755	1901
33	2180	2090	2031	2040	1954	2103
34	2408	2307	2238	2247	2162	2312
35	2637	2521	2448	2452	2378	2527
36	2864	2731	2656	2654	2594	2745
37	3086	2935	2862	2854	2806	2966
38	3299	3134	3065	3054	3006	3186
39	3502	3330	3263	3256	3186	3403
40	3693	3525	3455	3466	3338	3617

SIEOG

Studio METRICS (MultcEnTRic Italian Charts Study)

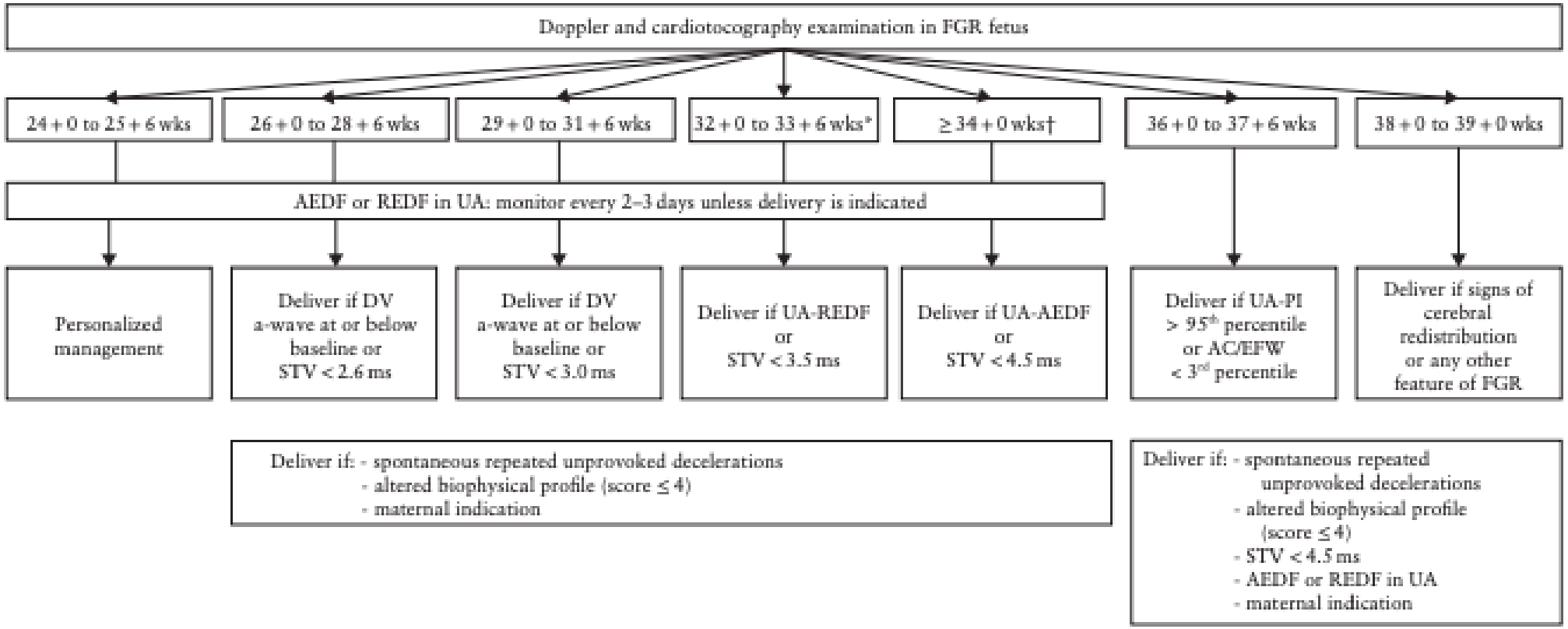
FETAL GROWTH RESTRICTION

MONITORAGGIO ECOGRAFICO

isuog.org GUIDELINES

ISUOG Practice Guidelines: diagnosis and management of small-for-gestational-age fetus and fetal growth restriction

Early FGR: *GA < 32 weeks, in absence of congenital anomalies*	*Late FGR:* *GA ≥ 32 weeks, in absence of congenital anomalies*
AC/EFW < 3rd centile *or* UA-AEDF *Or* 1. AC/EFW < 10th centile *combined with* 2. UtA-PI > 95th centile *and/or* 3. UA-PI > 95th centile	AC/EFW < 3rd centile *Or at least two out of three of the following* 1. AC/EFW < 10th centile 2. AC/EFW crossing centiles > 2 quartiles on growth centiles* 3. CPR < 5th centile *or* UA-PI > 95th centile



MONITORAGGIO ECOGRAFICO

Main vessels utilized to document placental vasculopathy

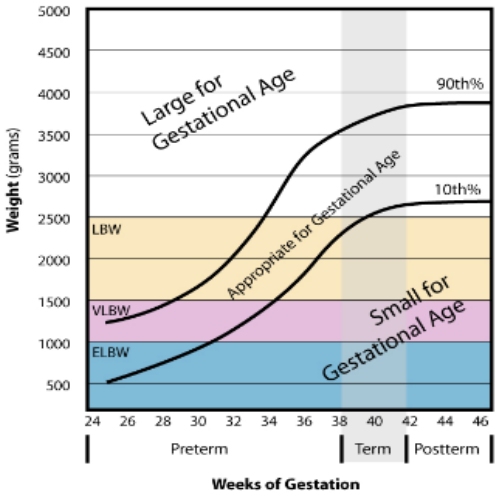
FETO-PLACENTAL DOPPLER

FETAL SURVEILLANCE

UTERINE ARTERIES	UMBILICAL ARTERY	MIDDLE CEREBRAL ARTERY	DUCTUS VENOUS
Abnormal trophoblast invasion	Decresed villous tree	Hypoexemia Hypercarbia	Acidemia Heart Disfunction

LARGE FOR GESTAIONAL AGE

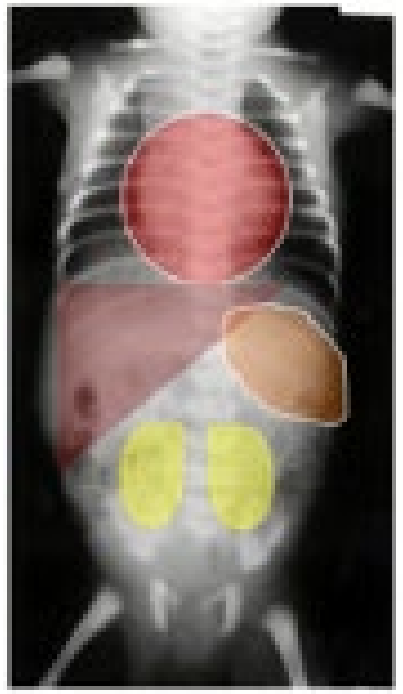
MONITORAGGIO ECOGRAFICO



FETAL SIGNS OF DISEASE ACCELERATION DUE TO POOR MATERNAL GLYCEMIC CONTROL

- ✓ AC growth >14mm/week
- ✓ AC >75th
- ✓ EFW>90th
- ✓ EFW>4000g
- ✓ Polhydramnios
- ✓ Organomegaly of individual organ

INCREASING FETAL SURVEILLANCE AND CONSIDERING DELIVERY



III TRIMESTER FETOPATHY

Large shoulders
Large abdomen
Organomegaly
High fat content
Polyuria

MONITORAGGIO FETALE

Table 4. Antepartum fetal surveillance tests in women with pregestational diabetes.

	ACOG	NICE	FIGO	Other
Non-Stress Test	Weekly evaluation starting at 36 weeks of gestation.	Weekly at 38 weeks of gestation. Could start before in risk of fetal growth restriction	According to local protocol.	SOGC: Weekly evaluation starting at 36 weeks of gestation.
Biophysical Profile	Starting at 32 weeks of gestation. Follow-up twice a week in case of abnormalities.	Recommended after 32 weeks of pregnancy and can be performed earlier in cases of high risk of stillbirth	According to local protocol.	ADA: Starting at 32 weeks of gestation. Weekly follow-up.
Contraction Stress Test	Starting between 32 and 34 weeks of gestation. Controversial use.	Not discussed.	Not discussed.	Not discussed.
Ultrasound and Amniotic Fluid Analysis	Starting at 32 weeks of gestation. Growth ultrasound between 34 and 36 weeks of gestation. Amniotic fluid assessment starting at 32 weeks.	Starting at 28 weeks of gestation, followed by evaluations at 32, 36 and 38–39 weeks of gestation.	Performing ultrasound every two to four weeks until resolution of pregnancy.	SOGC: Starting with fetal ultrasound at 36 weeks of gestation, followed by weekly follow-up.
Fetal Doppler Ultrasound	Non-discussed. Used in high-risk pregnancies.	Used in pregnancies complicated with fetal growth restriction.	Non-discussed. Used in high-risk pregnancies.	Non-discussed. Used in high-risk pregnancies.

ACOG—American College of Obstetricians and Gynecologists; NICE—National Institute for Health and Care Excellence; FIGO—International Federation of Gynecology and Obstetrics; SOGC—Society of Obstetricians and Gynaecologists of Canada; ADA—American Diabetes Association; high-risk pregnancies—poor glycemic control, poor compliance, vascular disease, nephropathy, previous stillbirth.

From 36-38 weeks

From 32 weeks

From 28-39 weeks

Braveman-Poyastro A, et al, JCM, 2024

MONITORAGGIO CARDIOTOCOGRAFICO

14
OTTOBRE 2021

RACCOMANDAZIONI SULLA CARDIOTOCOGRAFIA ANTE PARTUM

FONDAZIONE CONFALONIERI RAGONESE
SU MANDATO SIGO, AOGOI, AGUI

Quindi, l'NST non è indicato genericamente in tutti i casi di gravidanza a rischio, bensì solo in quelli ove vi è un rischio effettivo e documentato di ipossia cronica:

- diabete pregestazionale e diabete gestazionale non compensato
- ipertensione preesistente alla gravidanza, ipertensione gestazionale, preeclampsia
- malattie renali croniche materne
- lupus eritematoso sistemico e connettiviti con autoanticorpi anti SS-A e SS-B
- sindrome da anticorpi antifosfolipidi
- emoglobinopatie ed altre anemie materne con emoglobina <8 g/dl
- ipossia materna severa
- ipertiroidismo materno scompensato
- cardiopatie cianogene materne
- oligoidramnios
- restrizione della crescita, definita secondo i criteri del Delphi Consensus recepiti dalle linee guida ISUOG
- alloimmunizzazione materno-fetale
- gravidanza gemellare con crescita discordante dei gemelli
- gravidanza ≥41settimane + 0 giorni
- diminuita percezione dei movimenti fetali da parte della gestante; quest'ultima indicazione è occasionale, poiché in questo caso è richiesta l'esecuzione dell'NST, ma se il tracciato è reattivo ed il liquido amniotico, valutato tramite misura della tasca massima, è presente in quantità regolare (tasca massima >2 cm) non vi è indicazione alla ripetizione dell'esame.

MONITORAGGIO ECOGRAFICO

CHI	QUANDO
DG in trattamento con dieta, ben compensato, adeguato accrescimento fetale e senza altre complicanze	Basso rischio ostetrico
DG in terapia insulinica con compenso	Da 38-39 settimane
DG senza adeguato compenso glicemico	Da 32-36 settimane, 1 volta a settimana
Diabete pregestazionale in scarso compenso glicemico	Da 32 settimane, 2 volte a settimana
Diabete pregestazionale con buon compenso glicemico e senza vasculopatia, disturbi ipertensivi, alterazioni della crescita fetale o del liquido amniotico	Da 36 settimane
Diabete e restrizione della crescita fetale	Inizio precoce e va personalizzato

Raccomandazioni Sulla Cardiotocografia Ante Partum Sigo, Aogoi, Agui, 2021

MONITORAGGIO CLINICO-ECOGRAFICO

Prima visita

***Stile di vita**

(dieta e attivitá fisica)

*** Valutazione benessere materno**

(Ecocardiogramma, fundus oculi, diario pressorio)

*** Valutazione benessere fetale**

(Eco ostetrica+Velocimetria Doppler)

DIAGNOSI DI GRAVIDANZA

MONITORAGGIO CLINICO-ECOGRAFICO

Visita di Controllo

BUON COMPENSO

***Controlli ogni 3-4 settimane**

(Eco ostetrica +Velocimetria Doppler)

***CTG da 36 settimane**

Visita di Controllo

SCARSO COMPENSO

***Verifica schema dietetico**

(valutazione della dietista)

***Verifica schema terapeutico**

(valutazione del diabetologo)

***Controlli ogni 1-2 settimane**

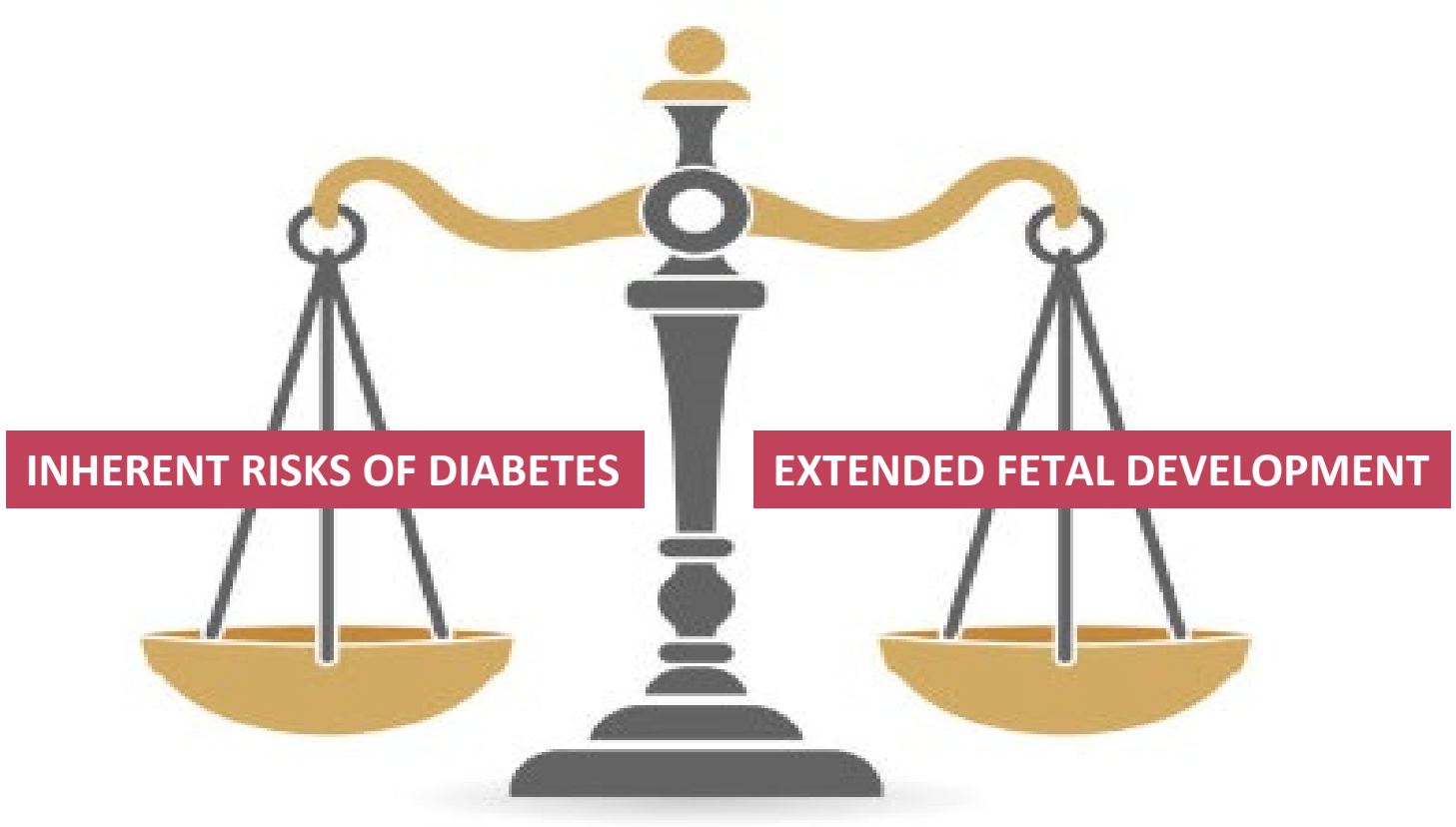
(Eco ostetrica +Velocimetria Doppler)

***CTG da 32 settimane a cadenza personalizzata**

TIMING DEL PARTO

TIMING DEL PARTO

OPTIMAL TIMING FOR DELIVERY → DELICATE BALANCE



ADVERSE FETAL OUTCOMES

- Stillbirth
- Prematurity

ADVERSE OBSTETRIC OUTCOMES

- Higher rates of cesarean sections
- Higher rates of instrumental delivery
- Haemorrhage
- Perineal tears III-IV grade
- Maternal satisfaction

ADVERSE NEONATAL OUTCOMES

- Low APGAR scores
- LGA newborns
- Respiratory distress syndrome
- Neonatal jaundice
- Admission to the intensive care unit
- Seizures
- Hypoxic-ischemic encephalopathy

TIMING DEL PARTO

Necessity of addressing
specific decision-making considerations
related to delivery timing in pregestational diabetic women

- Constant monitoring of blood glucose levels (compliance)
- Assessing fetal growth (FGR/LGA)
- Assessing placental function
- Comorbidities (hypertensive disorders, intrahepatic cholestasis…)

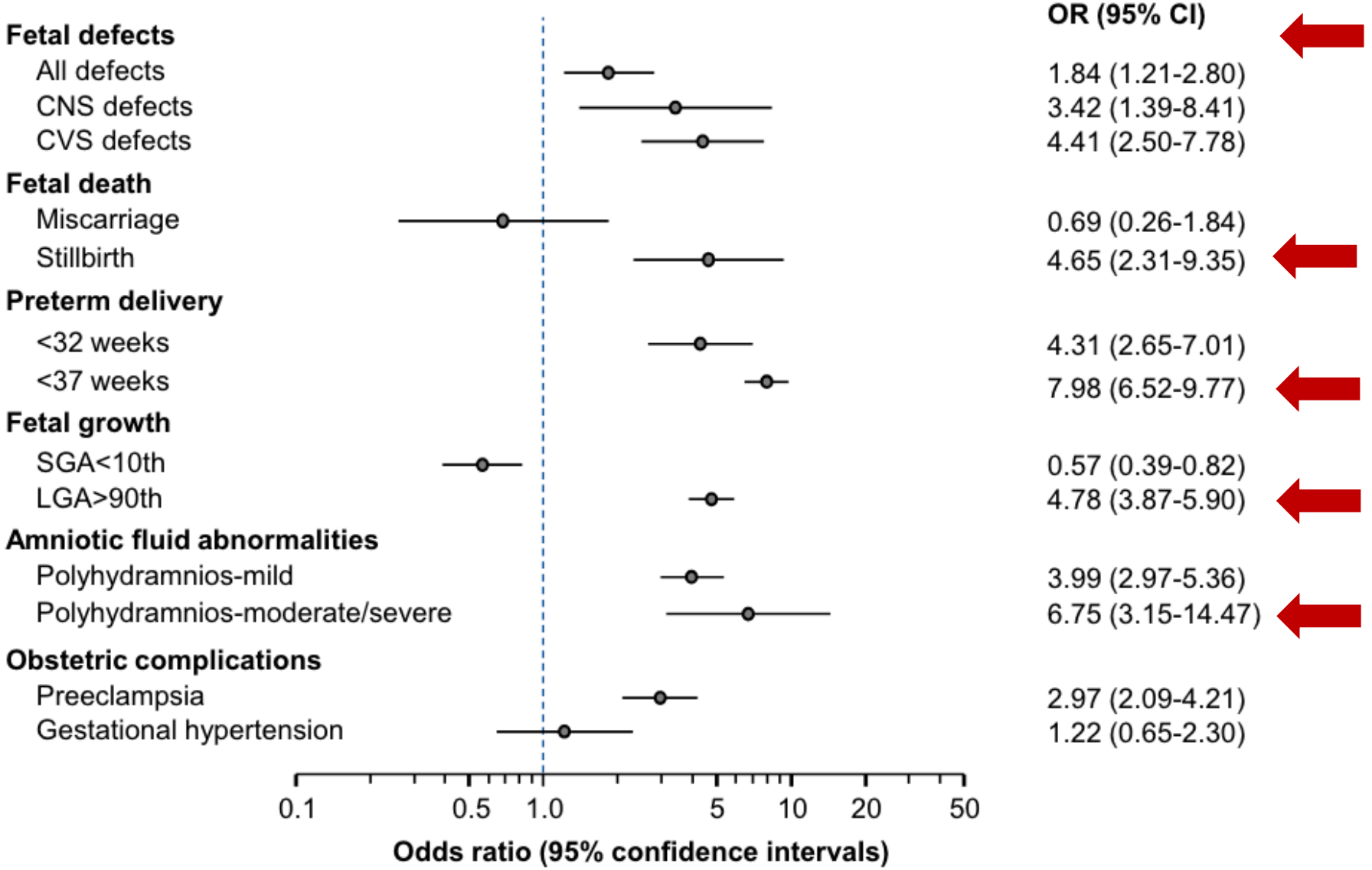
TIMING DEL PARTO

J Perinat Med. 2023 Sep 7;52(1):30-40. doi: 10.1515/jpm-2023-0183. Print 2024 Jan 29.

Maternal and neonatal complications in pregnancies with and without pre-gestational diabetes mellitus

Rebecca Karkia [1 2], Tara Giacchino [2 3], Helen Watson [1], Andrew Gough [4], Ghada Ramadan [5], Ranjit Akolekar [2 3]

UK, from 2010 to 2022
53,649 singleton pregnancies,
509 (1.0 %) with pre-existing DM
49,122 (99.0 %) without diabetes



Karkia, et al, J Perinat Med . 2023

TIMING DEL PARTO

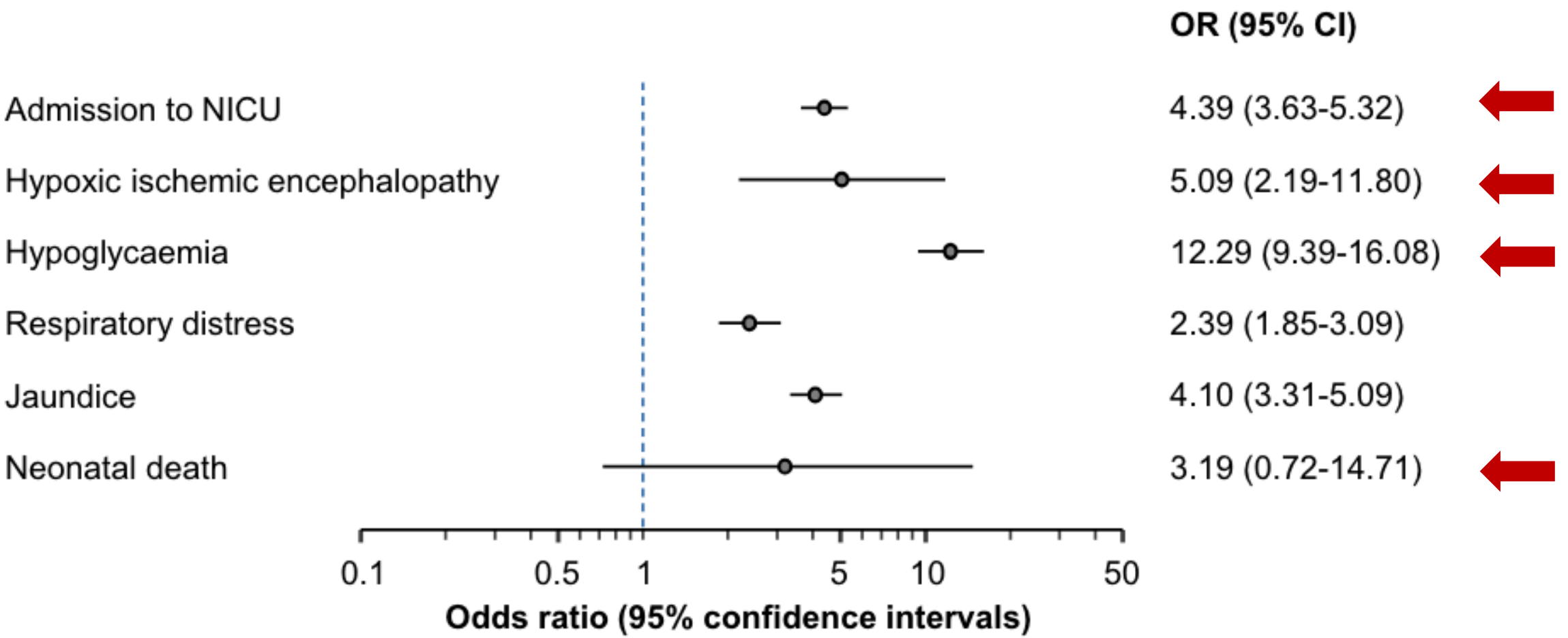
Table 4: Univariate and multivariate logistic regression analysis demonstrating the association of type 1 diabetes mellitus with intrapartum pregnancy complications.

Intrapartum adverse outcomes	Univariate analysis		Multivariate analysis	
	OR (95 % CI)	p-Value	OR (95 % CI)	p-Value
Mode of delivery				
Unassisted vaginal	0.18 (0.13–0.24)	<0.001	0.21 (0.15–0.30)	<0.001
Operative vaginal	0.66 (0.38–1.13)	0.129	–	–
Elective caesarean delivery	4.16 (3.18–5.44)	<0.001	3.28 (2.36–4.58)	<0.001
Emergency caesarean delivery	2.69 (2.06–3.51)	<0.001	1.74 (1.24–2.43)	<0.001
Failure to progress	1.12 (0.66–1.89)	0.673	–	–
Fetal distress	2.96 (2.17–4.04)	<0.001	3.18 (2.27–4.47)	<0.001
Postpartum haemorrhage				
Moderate	2.33 (1.64–3.32)	<0.001	1.12 (0.78–1.61)	0.543
Severe	1.17 (0.43–3.15)	0.758	–	–
Obstetric anal sphincter injury	1.07 (0.40–2.88)	0.896	–	–
Shoulder dystocia				
All	0.72 (0.18–2.92)	0.649	–	–
Severe	2.30 (0.32–16.60)	0.408	–	–

OR, odds ratio; CI, confidence interval.

Karkia, et al, J Perinat Med . 2023

TIMING DEL PARTO



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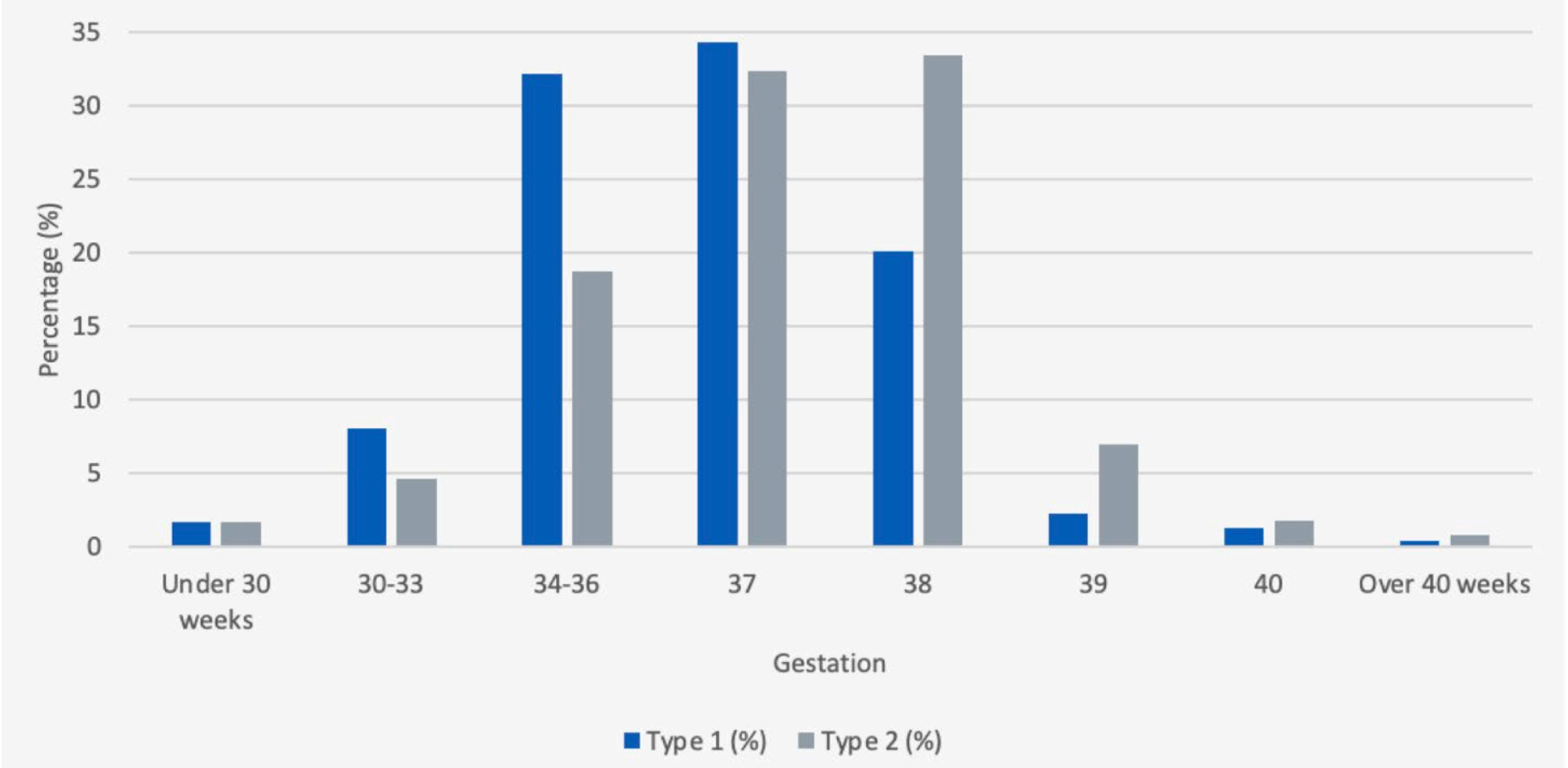
TIMING DEL PARTO

Percentage of live and stillbirth by type (T1DM vs. T2DM) and gestation at delivery in 2021 and 2022



https://digital.nhs.uk/data-and-information/publications/statistical/national-pregnancy-in-diabetes-audit/2022

TIMING DEL PARTO

Original Research

Risk of Stillbirth in Pregnancies Complicated by Diabetes, Stratified by Fetal Growth

Eliza R. McElwee, MD, Emily A. Oliver, MBBS, Kelli McFarling, MD, Ashley Haney, BS, Ryan Cuff, MD, Barbara Head, MD, Harsha Karanchi, MD, Aundrea Loftley, MD, and Matthew M. Finneran, MD

Table 6. Relative Risk of Stillbirth Comparing Fetuses With Pathologic Fetal Growth in Pregnancies Complicated by Gestational and Pregestational Diabetes Mellitus

GA (wk)	GDM-Related LGA	GDM-Related SGA	PDM-Related AGA	PDM-Related LGA	PDM-Related SGA
34	2.0 (1.4–2.9)	4.7 (3.3–6.7)	7.2 (5.4–9.7)	9.1 (6.8–12.8)	15.6 (9.3–26.1)
35	2.2 (1.6–3.0)	3.7 (2.6–5.2)	6.0 (4.6–7.9)	14.8 (11.4–19.3)	19.2 (12.6–29.2)
36	3.6 (2.9–4.4)	2.7 (2.0–3.8)	4.4 (3.4–5.7)	12.9 (10.3–16.31)	17.0 (11.7–24.7)
37	4.4 (3.5–5.5)	3.5 (2.6–4.8)	5.4 (4.2–7.0)	21.8 (17.4–27.2)	13.5 (8.5–21.2)
38	5.4 (4.4–6.6)	4.0 (3.0–5.4)	5.7 (4.4–7.3)	21.3 (16.8–27.0)	14.8 (9.5–22.9)
39	3.6 (2.8–4.8)	2.8 (1.9–4.1)	3.2 (2.2–4.7)	16.99 (12.2–23.7)	9.7 (5.1–18.4)

GA, gestational age; GDM, gestational diabetes; LGA, large for gestational age; SGA, small for gestational age; PDM, pregestational diabetes; AGA, appropriate for gestational age.
Data are relative risk (95% CI) unless otherwise specified. Referent: gestational diabetes-related, growth appropriate for gestational age.

Pregnancies complicated by both GDM and pregestational diabetes affected by pathologic fetal growth have an increased risk of stillbirth with advancing gestational age.

This risk is significantly higher with pregestational diabetes, especially pregestational diabetes with LGA fetuses.

TIMING DEL PARTO

NICE 2020	ADIPS 2020	SOGC 2019	ACOG 2018
Type 1 or type 2 diabetes and no other complications: **37-38+6** wks < 37 weeks for women who have metabolic or other maternal or fetal complications	**By the end of 38 completed weeks** gestation, depending on the presence of fetal macrosomia, glycaemic levels and any other complicating factors.	**38-40** wks gestation depending on their glycemic control and other comorbidity factors	Without vascular complications and with well controlled blood glucose levels, deliver at **39 0/7- 39 6/7** wks With vascular complications or poorly controlled blood glucose: 36 0/7 -38 6/7 wks; in rare cases, even earlier

TIMING DEL PARTO

ACOG 2018

Without vascular complications and with well controlled blood glucose levels, deliver at **39 0/7- 39 6/7** wks

With vascular complications or poorly controlled blood glucose: 36 0/7 -38 6/7 wks; in rare cases, even earlier

Induzione del travaglio/TCE

BUON COMPENSO

***39 settimane**

SCARSO COMPENSO

***da 36 settimane**

No controindicazione a travaglio di prova (TOLAC)

Take home message

- ✓Approccio multidisciplinare in corso di gravidanza *(triade: ginecologo, diabetologo, dietista)*
- ✓Ruolo dello screening per la preeclampsia
- ✓Ecografia di riferimento *(con ecocardiografia)*
- ✓Valutazione della crescita fetale *(LGA vs. FGR)*
- ✓ Timing parto *(36 vs 39 settimane)*

Grazie per l'attenzione!

MONITORAGGIO ECOGRAFICO

Challenges in Diabetic Placenta

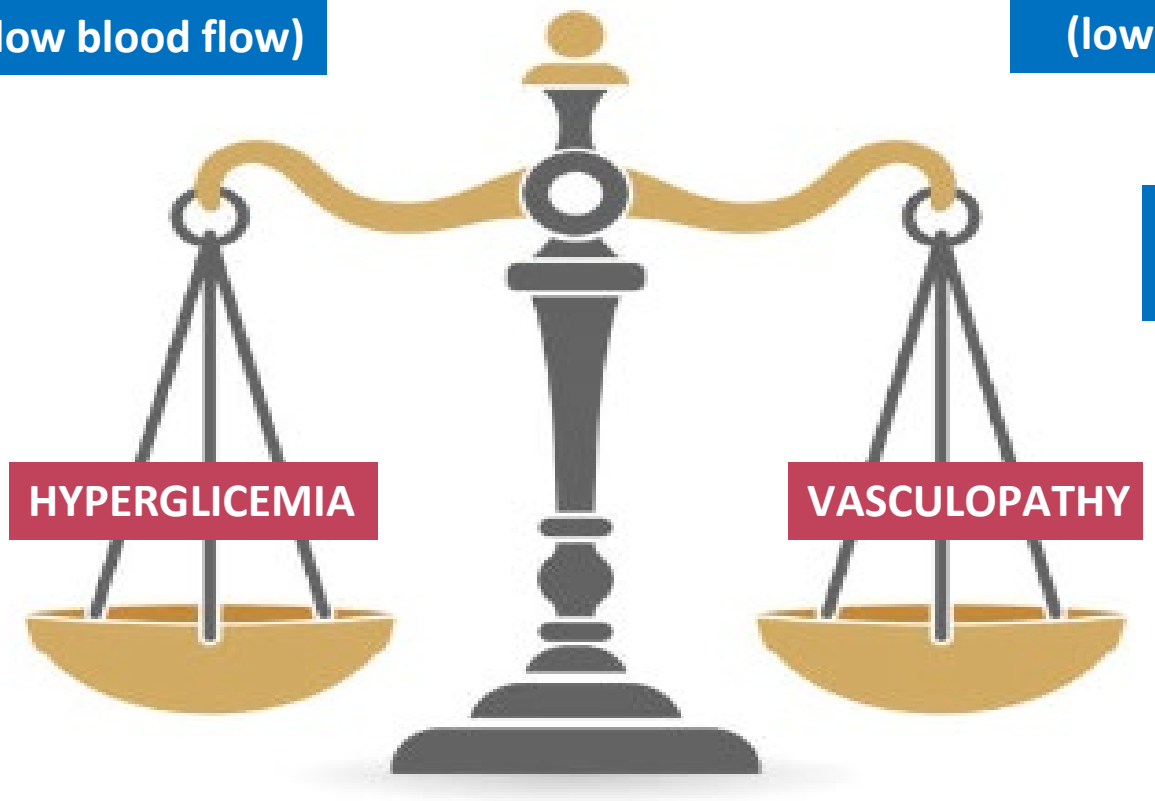
NORMAL PLACENTA
(normal blood flow)

LARGE PLACENTA
(inappropriatly low blood flow)

NORMAL PLACENTA
(low blood flow)

LARGE PLACENTA
(hight blood flow)

SMALL PLACENTA
(low blood flow)



HYPERGLICEMIA

VASCULOPATHY

TIMING DEL PARTO

Conclusions: The maternal and neonatal complications in pregnancies with pre-existing DM are significantly increased compared to those without DM despite a decade of intensive multidisciplinary antenatal care. Further research is required to investigate strategies and interventions to prevent morbidity and mortality in pregnancies with pre-gestational DM.

Strategies:

- ✓ Improving education
- ✓ Pre-conception planning
- ✓ Improving glycemic control prior to embarking on the pregnancy
- ✓ Administration of low-dose Aspirin
- ✓ Use CGM/flash monitoring

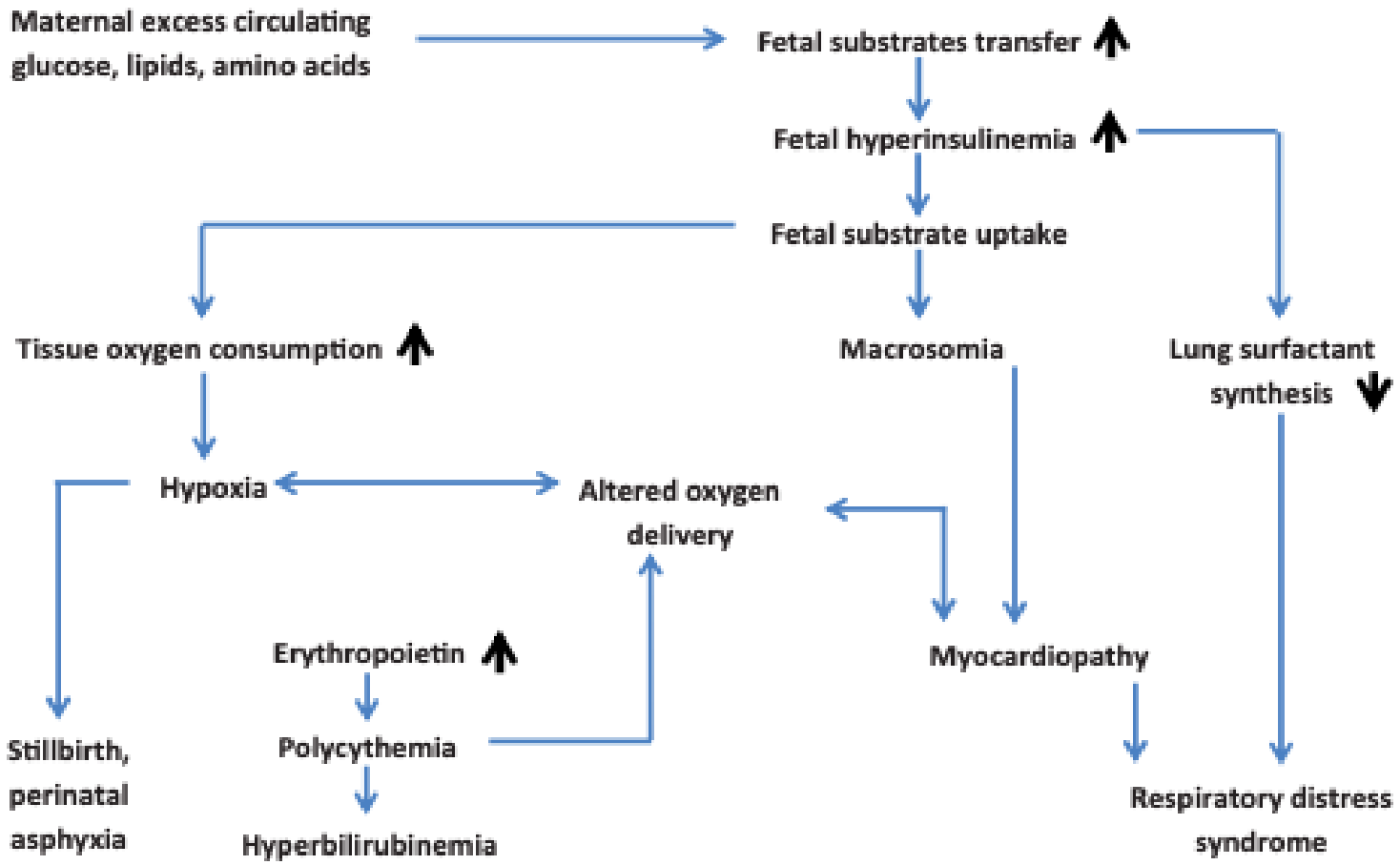
Karkia, et al, J Perinat Med . 2023

MONITORAGGIO ECOGRAFICO

ANATOMY

PREGESTATIONAL DIABETES

CONGENITAL DEFECTS (heart, skeleton, CNS) Incidence 6-12%



FIGO, Initiative on Gestational Diabetes Mellitus, 2015
ACOG, Pregegstaional Diabetes, 2016